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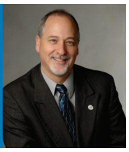

Roy T. Fielding: Understanding the REST Style

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Roy T. Fielding reminisces about his PhD dissertation, which defined the Representational State Transfer architectural style.

Scratch the surface of most modern networked applications, and you'll see the various application parts exchanging data using an approach called Representational State Transfer (REST). Developers can learn about the origins of REST by reading Roy T. Fielding's PhD thesis for the University of California, Irvine (UCI), published in 2000 (www.ics.uci.edu/~fielding/pubs/dissertation/top.htm). This is required reading for those wanting to be REST experts. I spoke with Roy about how the REST concepts were developed and how they came to be described in his thesis. You can see the entire interview with Roy at www.computer.org/computingconversations.

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Roy was an early participant in Web protocol and software development as it emerged in the early 1990s. The first implementations of Web browsers and servers were created by Tim Berners-Lee at CERN using a NeXt computer, and they were quickly ported to many different computers and operating systems. For each new use of the Web, ideas about how its protocol could be improved to better support the new idea often followed. To change the protocol, you had to send an email to a list that included virtually all of the Web developers in the world:

> *HTTP and HTML were built informally, primarily using mailing lists as the coordination mechanism. [Developers from all over the world] would talk about a new feature. Frequently, we would come up with an idea in one time zone and someone would implement it in another time zone; by the next morning, you would know what worked and what didn't work with that feature. So it was very free-form and very fast. At the time we were all computer scientists or researchers who were playing around, doing research, or providing our own resources on the Web.*

By 1994, the impetus for Web improvement moved from computer scientists and Web developers who were exploring a new space to an increasingly critical infrastructure for growing Web-based businesses:

> *As companies became involved, they wanted to find ways to use the Web corporately as one of their platforms, so it needed to be more "businesslike." One of the ways to make things more suitable for business is to create common standards for everyone to adhere to, rather than to adopt things as you go along.*

Roy coined the term REST to capture the idea that the elements of networked applications were exchanging their states using protocols across the network.

Berners-Lee and others formed the World Wide Web Consortium (W3C) at MIT to develop the standards that guide the Web today. Roy was invited to work on the standards for URLs and HTML, and eventually became the lead editor for HTTP:

> *As one of the developers of the Web protocol library libwww-perl, I was asked to help work on the standards. Because I was a graduate student at UCI, I had all the freedom in the world. I had finished all my classwork and started working on my dissertation. That gave me the ability to write for the Web in addition to the programming I was still doing for my thesis.*

As the Web grew rapidly in the mid-1990s and powerful businesses started embracing the Web, there were even more suggestions from the new stakeholders as to how to improve the protocols:

> *I was faced with the dilemma of having many competing interests working toward making the Web what they thought would be a better place. I needed to differentiate between ideas that were actually better for the Web and those that went back to some older version of architecture that didn't make any sense on the Internet.*

Instead of debating each new idea separately, Roy developed a model that captured the principles of how distributed applications should interact with one another:

> *I called it the "HTTP Object Model." At the time, object models were the "in" thing, so I called it an object model even though it had nothing to do with objects. It was a model of how I expected Web applications to behave. If someone offered a feature or described something they thought was wrong with the Web, I would use the model to show how HTTP worked and how the new feature might hurt or help. The model gave me some intellectual leverage to affect how the HTTP standard evolved.*

Roy's PhD research on software architecture helped him better understand and explain his model:

> *It wasn't until after I had done the literature search for software architecture that I figured out the right way to describe the HTTP model I had developed. I read a paper by Dewayne Perry and Alexander Wolf ["Foundations for the Study of Software Architecture," ACM SIGSOFT Software Eng. Notes, vol. 17, no. 4, 1992, pp. 40–52]—it was the only software architecture paper I could find that described architecture in terms of not only the components and connectors of typical architecture diagrams, but also the data that's processed through the system.*

During the late 1990s, Roy was oscillating between the high-stakes world of Internet standards development and the more academic approach for his PhD thesis:

> *One of the great benefits I had was the freedom to pursue these different areas. I was working on a team that was doing research on global software engineering environments, so I was trying to use the Web as a platform for software engineering. My research project was essentially what GitHub is today. As part of that, I could do all this other work that was related to it. It was one of the nice things about general research funding.*

But Roy also needed to finish his thesis and graduate:

> *I come from an academic background. My father is a professor of geography and urban economics, so I always wanted to complete a PhD. It was never a question of running off and joining a startup, even though my startup friends were becoming millionaires left and right.*

As his PhD program extended into its sixth year, Roy felt pressure from many directions to finish his thesis and move on. But although he had explored many interesting questions and had played an important part in the foundation of the Web industry, he still wasn't sure what his thesis would be about:

> *I was talking to a colleague, Larry Masinter, about a related subject,*

> *and was telling him how I'd done all this work but I didn't know what to do for my dissertation. He said, "You're the only one who can describe HTTP's design rationale—the details of why it's there and what it's good for—why don't you just do that?" But at the time, I hadn't considered that to be my academic work; it was just my practical work for the Web. For me, going back to researching and finding the real knowledge framework for architectural styles was my way of fitting it all together. I learned an entirely new vocabulary in order to write my dissertation.*

Roy wrote his dissertation as if he were writing a book on the architecture of HTTP. He coined the term REST to capture the idea that the elements of networked applications were exchanging their states using protocols across the network. He never expected that his thesis would be so widely read:

> *It's gratifying that people like to read my dissertation. It's an accessible piece of work. There's one equation, which is there just to have an equation. It's not actually necessary, but I felt I had to have one.*

It's rare that a PhD student has the flexibility and support of his or her institution to participate in developing an entirely new industry while researching a thesis about that industry. Roy sees his participation in both the academic and industrial worlds as an advanced form of technology transfer:

> *This freedom gave me the ability to do technology transfer beyond my wildest imagination. What's hilarious from my standpoint is that I was just having fun. I was given resources so I could do my good deed for the universe, but it was really about working with enjoyable people and having wonderful conversations. And I learned an incredible amount.*

They say that timing is everything. As Roy was starting his PhD, the Web was being invented. Roy finished his thesis in 2000, when the Web had forever changed communication, technology, and commerce worldwide. Finishing his PhD at the beginning of a new decade provided an opportunity to pause and reflect on the essential structure of Web technologies. His thesis continues to guide the architecture of today's modern distributed REST-style applications.

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