

## Serverless Programming (Function as a Service)

Serverless Computing (Function as a Service) is emerging as a new and compelling paradigm for the deployment of cloud applications, largely due to the recent shift of enterprise application architectures to containers and microservices.

From the perspective of an Infrastructure-as-a-Service (IaaS) customer, this paradigm shift presents both an opportunity and a risk. On the one hand, it provides developers with a simplified programming model for creating cloud applications that abstracts away most, if not all, operational concerns; it lowers the cost of deploying cloud code by charging for execution time rather than resource allocation; and it is a platform for rapidly deploying small pieces of cloud-native code that responds to events, for instance, to coordinate microservice compositions that would otherwise run on the client or on dedicated middleware. On the other hand, deploying such applications in a serverless platform is challenging and requires relinquishing to the platform design decisions that concern, among other things, quality-of-service (QoS) monitoring, scaling, and fault-tolerance schemes.

From the perspective of a cloud provider, serverless computing provides an additional opportunity to control the entire development stack, reduce operational costs by efficient optimization and management of cloud resources, and enabling a serverless ecosystem that encourages the deployment of additional cloud services.

Serverless platforms promise new capabilities that make writing scalable microservices easier and cost effective, positioning themselves as the next step in the evolution of cloud computing architectures. Most of the prominent cloud computing providers including Amazon, IBM, Microsoft, and Google have recently released serverless computing capabilities. There are also several open-source efforts including the OpenLambda project.

In this tutorial, we will present serverless computing, survey existing serverless platforms from industry, academia, and open source projects, identify key characteristics and use cases, and describe technical challenges and open problems. Our tutorial will involve a hands-on experience of using the serverless technologies available from different cloud providers (e.g. IBM, Amazon, Google and Microsoft). We expect our users to have basic knowledge of programming and basic knowledge of cloud computing.

Serverless computing is still in its infancy, hence it should be of interest to the ICDCS community, because there is an opportunity for researchers to understand it and shape it by addressing the challenges that it faces. We hope that this tutorial (along with the first ICDCS workshop on serverless computing WOSC 2017) provides the first steps in understanding the technology and architecture of Serverless computing.

**We expect the tutorial to be close to 5~6 hours with hands on tutorial for attendees, where we focus on the following topics**

1. Evolution of Serverless Computing (1 hour)
2. Present the Architecture of an Open Source Apache OpenWhisk Serverless computing platform (1.5 hours)
3. Hands on Tutorial of different Serverless platforms (Amazon, google, IBM, Microsoft) (2.5 hours)
4. Use cases using Apache OpenWhisk for mobile applications. (1 hour)

We can also present a shorter version (3 hours) of this tutorial which covers options items 2 (1 hour), 3-4 (2 hours).

**Names and bios of the Presenters:**

Paul Castro, Ph.D.: is a Research Staff Member at the IBM Watson Research Center. He has been active in research on mobile and pervasive computing, cloud infrastructure, wireless location systems, location databases, stream processing, and enterprise web applications and has been awarded several patents in these areas. He has worked on cloud services for supporting mobile applications running on various smart phone platforms. Work from his research in the area of multi-device application support was recently released as part of the IBM Bluemix Mobile Backend as a Service. He has earned two IBM Technical Achievement Awards for the IBM SmartCloud Web Meetings for mobile clients and the Intelligent Notification System. Most recently, he worked on IBM OpenWhisk for Bluemix, with a focus on mobile solutions.

Vatche Ishakian: is an Assistant Professor in the Computer Information Systems department at Bentley University, before starting his academic career, Vatche was a Research Staff Member at IBM Research working on several projects including IBM OpenWhisk serverless computing platform. Vatche Computer his PhD in Computer Science from Boston University. His research interests include distributed business process management, Services composition, and priced based models for cloud services.

Vinod Muthusamy: is a Research Staff Member in the Component Systems Group at the IBM T.J. Watson Research Center. He completed his PhD in Computer Engineering at the University of Toronto. Vinod's research interests include publish/subscribe event processing, and distributed business process management. Most recently, he worked on IBM OpenWhisk Serverless Computing platform.

Alekander Slominski: is a Research Staff Member in the Services and API Ecosystems Group at the IBM T.J. Watson Research Center. He is interested in development of applications for for future API Economy that take advantage of upcoming cloud programming approaches, such as serverless computings, for compositions and orchestration of components into business workflows. Most recently, he worked on IBM IBM OpenWhisk Serverless Computing platform.

#### **Relevant References for the tutorial:**

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- [5] Cloud functions, <https://cloud.google.com/functions/>, Online; accessed December 1, 2016.
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[13] First International Workshop on Serverless Computing

<https://sites.google.com/site/wosc2017/>