



# Cloud, Fog, Edge, and 5G

## What and Why?

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SHIFT, ShanghaiTech University

Lightning Talk at PTC'20

Honolulu, USA, 20 January 2020

<http://SHIFT.shanghaitech.edu.cn>



# 5G: People-Centric → IoT Network

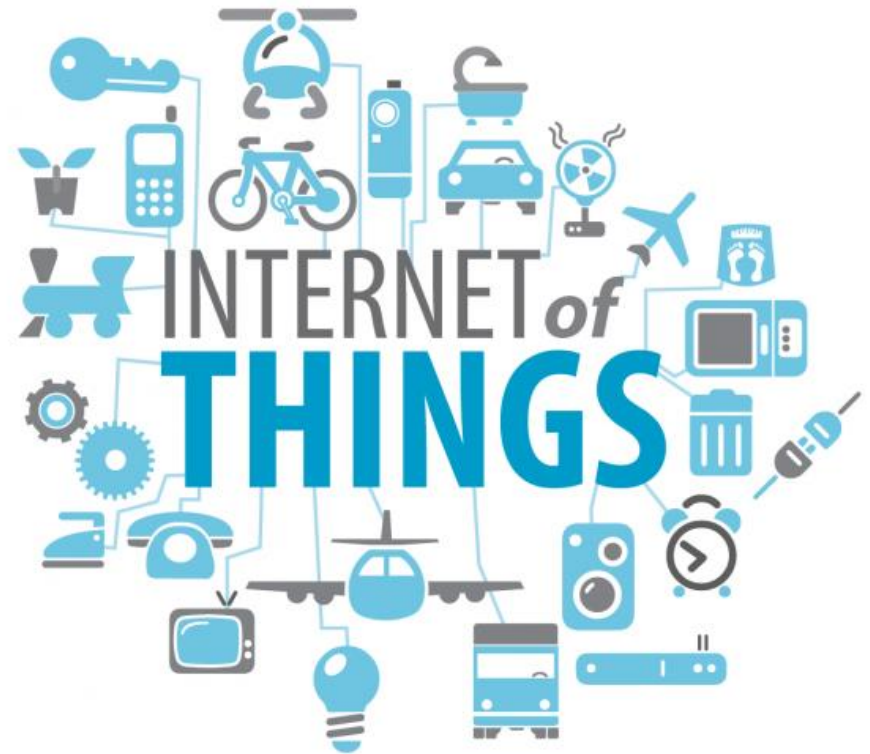


4 billion connected people

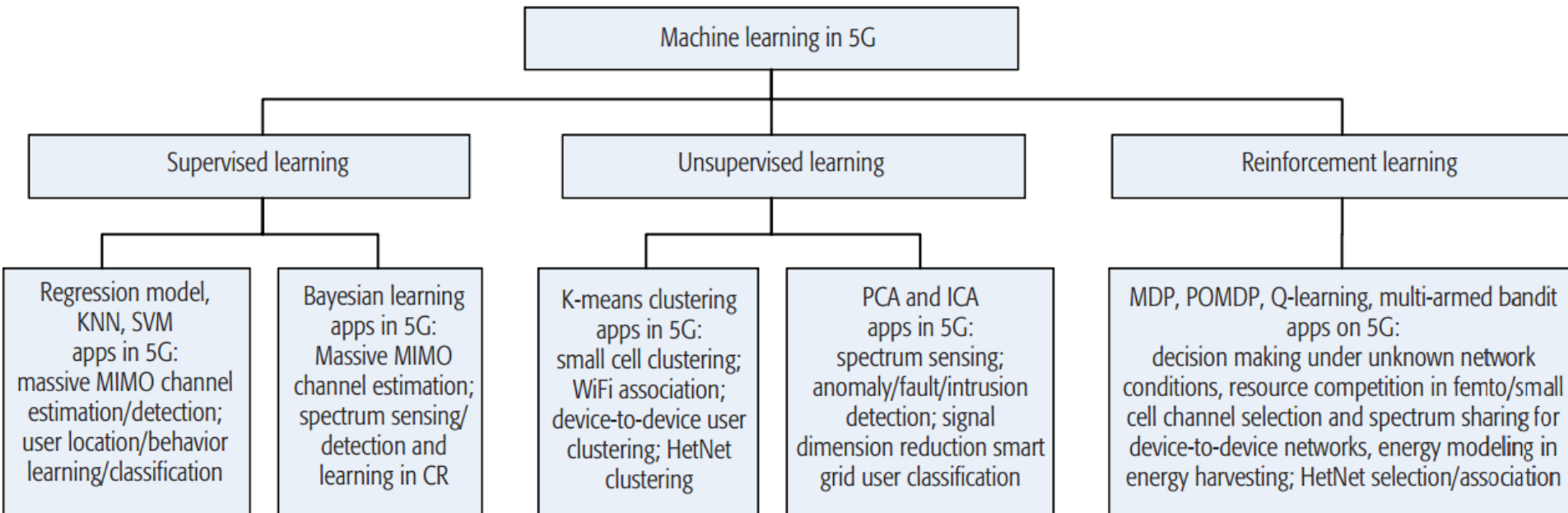


**Ovum Forecasts** (IoT World, May 2019)

IoT devices will grow to 21.5bn by 2023, while revenue will nearly double to \$860bn.



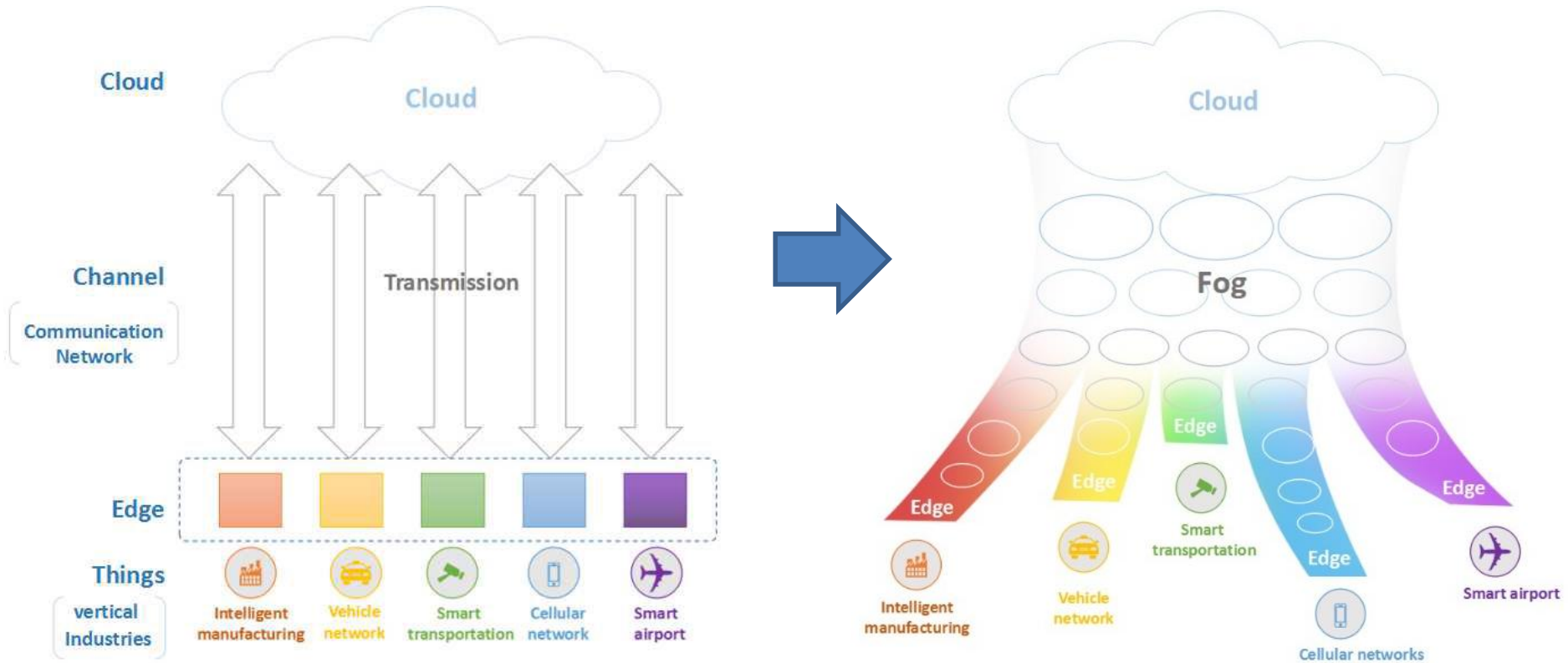
# Machine Learning in 5G



**Technologies:** massive MIMO, femto/small cells and heterogeneous networks (HetNets), cloud radio access networks, cognitive radio, full duplex, energy harvesting, etc.  
**Machine learning applications:** channel estimation/detection, spectrum sensing/access, cell/user clustering, switch and handover among HetNets, signal dimension reduction, energy modeling, user behavior analysis, location prediction, intrusion/fault/anomaly detection, cell/channel selection association.

**Machine Learning Paradigms for Next-Generation Wireless Networks, IEEE Wireless Communications, Apr. 2017.**

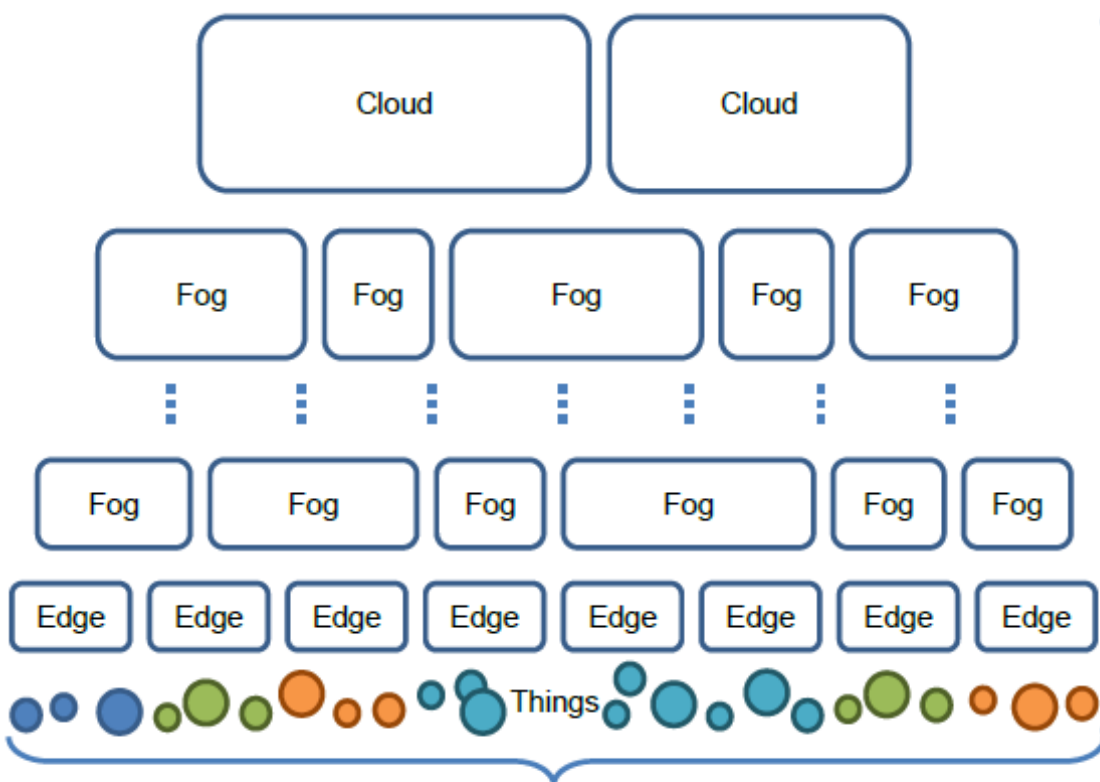
# Multi-tier Computing Networks



**FA<sup>2</sup>ST: Fog as a Service Technology**, IEEE Communications Magazine, Oct. 2018.

**Multi-tier Computing Networks for Intelligent IoT**, Nature Electronics, Jan. 2019.

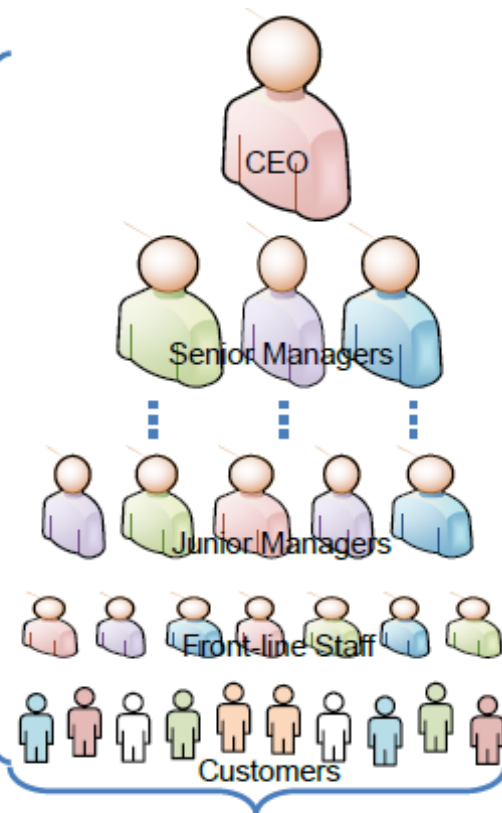
# Cloud, Fog, Edge and Things



IoT Networks with Various Intelligent Applications and Services

Multi-tier  
Computing  
Networks

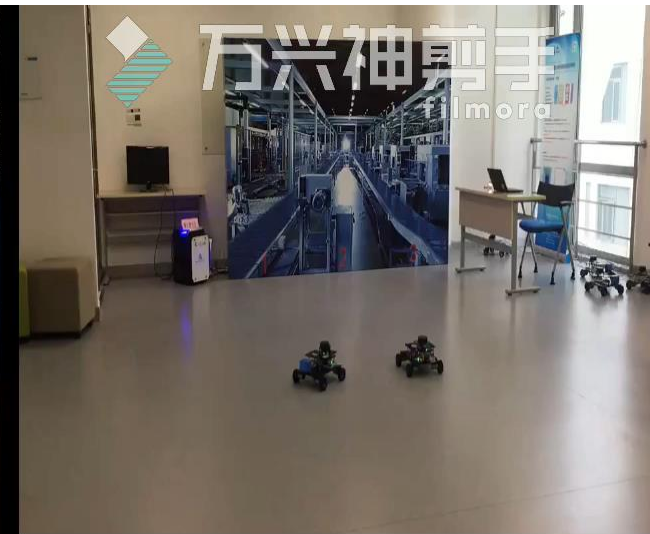
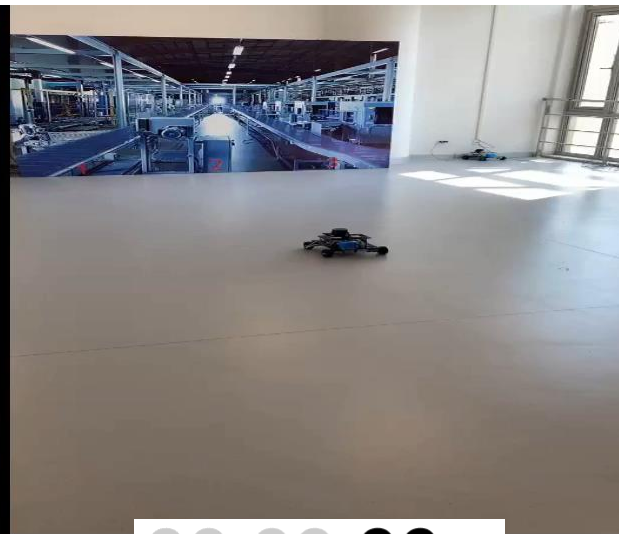
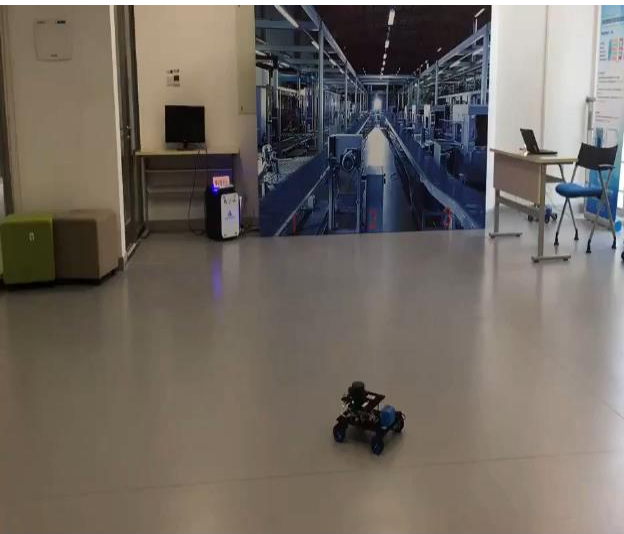
Hierarchy  
Organization  
Structure



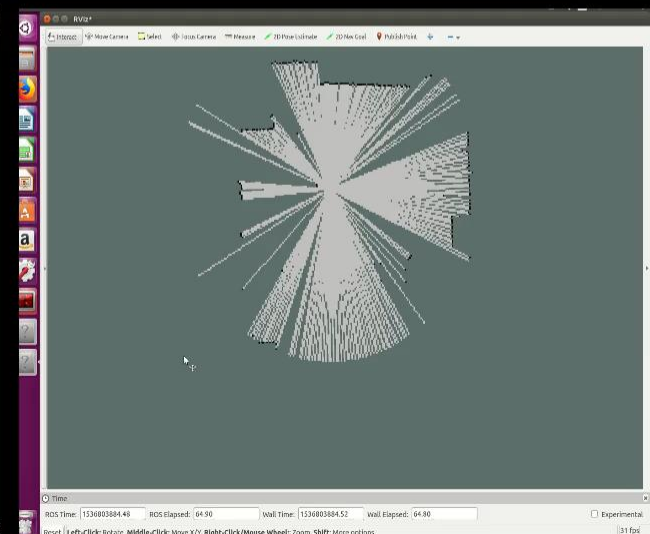
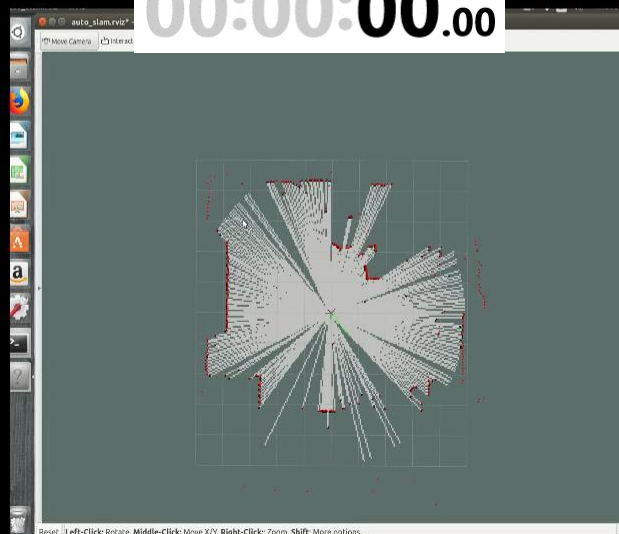
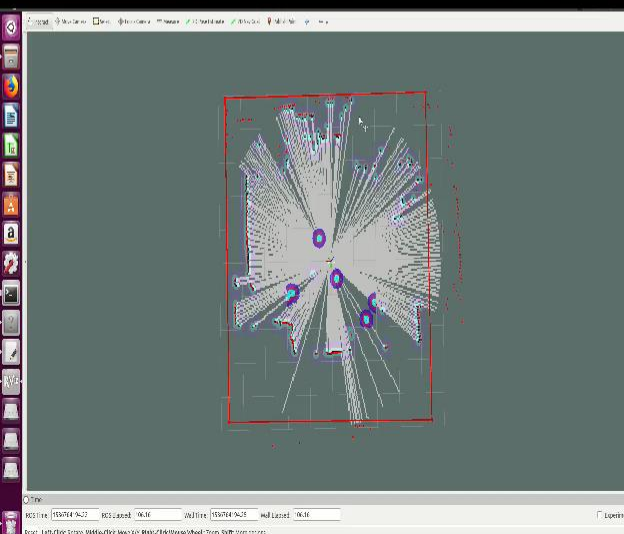
A Company with Multi-level Employees



# Robot SLAM



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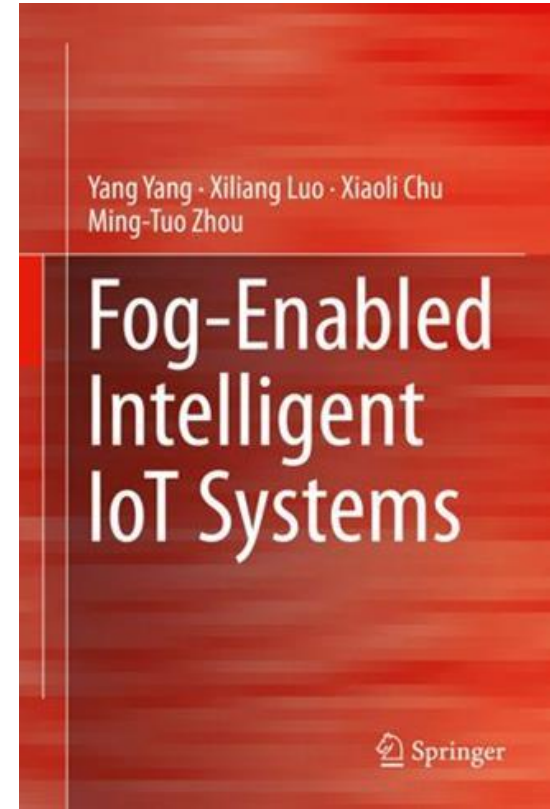
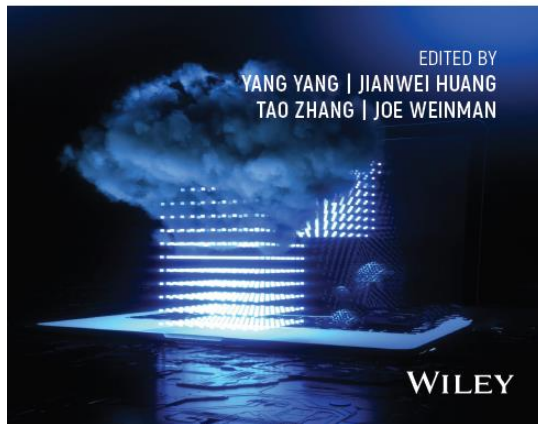
# Related publications



Information and Communication Technology Series • T. Russell Hsing and Vincent Lau, Series Editors

## FOG AND FOGONOMICS

CHALLENGES AND PRACTICES OF FOG  
COMPUTING, COMMUNICATION, NETWORKING,  
STRATEGY, AND ECONOMICS



- ◆ Y. Yang, J. Huang, T. Zhang, and J. Weinman (eds), “Fog and Fogonomics: Challenges and Practices of Fog Computing,” ISBN: 9781119501091, Wiley, 2020.
- ◆ Y. Yang, X. Luo, X. Chu, and M. T. Zhou, “Fog-Enabled Intelligent IoT Systems,” ISBN: 9783030231842, Springer, 2019.

A night-time photograph of the Golden Gate Bridge in San Francisco. The bridge's iconic red-orange towers and suspension cables are visible, with the city lights of San Francisco and the Marin Peninsula in the background. The sky is a deep blue, and the water reflects the city lights.

# **5G: More Data, More Computing Better Services.**

**Thank you!**

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