

**Edge to Cloud Solutions**  
ENGINEERED EXPERIENCES TO UNLOCK YOUR  
FULL POTENTIAL

---

**Marty Poniatowski**

HPE Press  
660 4th Street, #802  
San Francisco, CA 94107

**Edge to Cloud Solutions**  
**Engineered Experiences to Unlock Your Full Potential**  
Marty Poniatowski

© 2020 Hewlett Packard Enterprise Development LP

Published by:

Hewlett Packard Enterprise Press  
660 4th Street, #802  
San Francisco, CA 94107

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without written permission from the publisher, except for the inclusion of brief quotations in a review.

ISBN: 978-1-7346275-1-0

**WARNING AND DISCLAIMER**

This book provides information about the topics covered in Edge to Cloud Solutions. Every effort has been made to make this book as complete and as accurate as possible, but no warranty or fitness is implied.

The information is provided on an “as is” basis. The author, and Hewlett Packard Enterprise Press, shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this book or from the use of the discs or programs that may accompany it.

The opinions expressed in this book belong to the author and are not necessarily those of Hewlett Packard Enterprise Press.

## Feedback Information

At HPE Press, our goal is to create in-depth reference books of the best quality and value. Each book is crafted with care and precision, undergoing rigorous development that involves the expertise of members from the professional technical community.

Readers' feedback is a continuation of the process. If you have any comments regarding how we could improve the quality of this book, or otherwise alter it to better suit your needs, you can contact us through email at [hpepress@epac.com](mailto:hpepress@epac.com). Please make sure to include the book title and ISBN in your message.

We appreciate your feedback.

**Publisher:** Hewlett Packard Enterprise Press

**HPE Press Program Manager:** Michael Bishop



# Foreword

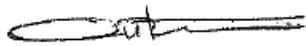
HPE is the Edge-to-Cloud Platform-as-a-Service Company. Whether you are a customer looking to deliver faster business outcomes, or a partner seeking to deliver the value that your customers are looking for, HPE's innovations are designed to accelerate what's next.

We believe the enterprise of the future will be edge-centric, cloud-enabled, and data-driven. By 2022, 55B devices will be connected worldwide<sup>1</sup> and more than 50% of that data will be created outside the data center or the cloud. Workloads and data are moving to the edge, and I believe the cloud is not a destination but rather an experience to be delivered wherever it is desired.

In this book, there are 20 different solutions and many more use cases discussed by HPE that can be tailored to fit specific customer needs. HPE GreenLake Central, for example, is helping unify the as-a-service experience for our partners and customers. Composable cloud, meanwhile, is helping drive the right cloud in a workload-optimized, integrated solution. And groundbreaking innovations, such as the HPE Container Platform, are enabling organizations to run both legacy applications and container applications with persistent storage connectivity that can be delivered and consumed as a service.

We hope you discover within this book and, more importantly, in your experience of the solutions described, the best path to accelerate outcomes and unlock value from all your data, everywhere.

Best Regards,



Antonio Neri  
Hewlett Packard Enterprise  
Chief Executive Officer

---

<sup>1</sup> Source: IDC



# Introduction

Since I published my last book, *Hybrid IT and Intelligent Edge Solutions*<sup>2</sup>, three industry trends have emerged to become dominant: 1) the explosion of data at the edge; 2) innovation in the cloud; and 3) the power and value of data.

The edge consists of billions of people and trillions of devices all generating data like crazy. What to do with these zettabytes is a question that many organizations are considering. In order to use this data, there must be devices that are seamlessly connected in a secure manner.

Every organization that I work with expects that they will have a consistent experience between the private and public cloud. Part of this experience is paying for IT services based on the consumption of resources whether in the public or private cloud. Solutions are optimized based on where workloads are run, including containers on VMs and bare metal, and then paid for based on usage. All of these considerations add a lot of complexity to this problem, and experts are needed for its planning and implementation.

Availability of data has skyrocketed yet getting value out of data is complex. To unlock insights from data takes innovative technology and expertise. We are realizing value from a small percentage of data, only 6% according to Gartner, and, herein lies a great opportunity, those who get intelligence from their data will be the ones to lead.

*Edge-to-Core Solutions* covers a variety of technologies that relate to the trends and topics that demonstrate the thought leadership of Hewlett Packard Enterprise (HPE). The following is a list of the chapters with just a word on each topic:

- Artificial Intelligence which is an initiative that virtually every firm has underway
- Internet of Things (IoT) which taps into a whole new world of data that can be used for a variety of reasons
- Pay-per-use which is Consumption-based pricing that results in paying only for what you use in both your private cloud and public cloud: yes, you can do this with HPE in your private cloud!
- Three chapters on HPE OneView and Synergy:
  - OneView which now allows you to look at your infrastructure as code
  - Synergy, a new category of composable infrastructure to simplify hybrid IT
  - Integration of OneView with ServiceNow, Nagios, and Splunk

---

<sup>2</sup> Marty Poniatowski, *Hybrid IT and Intelligent Edge Solutions* (San Francisco: Hewlett Packard Enterprise Press, 2018)

- Two storage chapters with the first covering software-defined storage, which is becoming mainstream, and, the second dealing with system-defined storage, which has long been the gold standard for integrated data solutions.
- Three cloud-related chapters:
  - Cloud Management Platform (CMP) Morpheus that provides a seamless public-private cloud experience
  - Managing containers of all types with HPE Container Platform including both stateless and stateful applications
  - Evaluating workloads for migration to private and public cloud with HPE Right Mix Advisor
- Two chapters on Aruba networking innovations: the first is Software-Defined Branch (SD-Branch) which is used in retail, hospitality, healthcare, and any distributed organization, and the second is Aruba's next-gen switching portfolio designed for the aforementioned IoT and other demands that are crushing legacy networks.
- Cybersecurity and other enhancements that can deliver on the promise of AI, performing real-time analysis of large data sets using graph analytics in-memory
- Cloudless computing which is a new and simplified approach to hybrid IT being driven by HPE
- The Circular Economy in which the full lifecycle of technology is taken into consideration from the initial purchase to recycling and reuse
- Persistent memory which changes the way in which data-intensive workloads can achieve greatly increased performance and other benchmarks
- High Performance Computing (HPC) chapter in which an example HPC environment is covered. This chapter also contains an overview of the HPE compute portfolio and Pensando networking.

HPE is a leader in innovation to drive your business forward as indicated by the many advancements that have been added since my last book. I hope that you find the chapters in this book useful to you and, as always, you can contact me directly if you have questions, comments or insights on how to accomplish this journey from edge to cloud together.

Thank you,

Marty Poniatowski

## About the Authors

This book consists of submissions from many authors who are experts in the technologies for which they crafted the chapter. The authors cover the spectrum of HPE experts from front-line Solution Architects to those in the role of Chief Technology Officer in various specialties. I worked closely with the authors to produce a book that comes as close as possible to reading as if one author produced the entire book.

### Primary Author

**Marty Poniatowski** is a Senior Director at Hewlett Packard Enterprise managing the presales technical experts in the East of the United States that are focused on the portfolio of HPE solutions as well as those of our partners. His team is comprised of Account Chief Technologists and Enterprise Architects who focus on the key initiatives of their clients and craft solutions to these complex problems. In so doing, his team works not only with HPE services and products but also firms with which HPE has partnerships.

This is Marty's 20th technology-related book, and he holds graduate degrees in Information Technology (New York University) and Management, and an undergraduate degree in Electrical Engineering.

### Chapter Authors

The following is a list of authors with the chapter number on which they worked immediately before their name. In some cases multiple authors contributed to a chapter.

**1 John Tsang** leads the IoT-Edge and Big Data-AI presales for HPE North America. His responsibilities include executing the go-to-market and enabling sales, marketing, and services readiness to grow the PAN HPE IoT business. He is executing new IoT/AI solutions to help customers transform and take advantage of this tremendous technology revolution underway.

**2 Steve Haldeman** is an HPE Distinguished Technologist with extensive experience in the Internet of Things (IoT), Big Data, and AI to strategic business and technical consultation for HPE customers and partners. He has held prior technical and business leadership roles including Director-level leadership and Senior Solution Architect positions in the Internet of Things (IoT), Cloud Computing, Big Data, Artificial Intelligence/Machine Learning, Software-Defined Infrastructures, and High Performance Computing.

**3 Larry Fondacaro** is Manager of the HPE East Enterprise Architecture (EA) team which provides both business and technical solutions across all industry verticals to HPE enterprise customers. His team is responsible for representing the entire HPE portfolio as well as integrating third-party components and applications to best solve customers' business outcomes.

**4 Steve Gorgone** is a senior Enterprise Architect for HPE, focused on delivering end-to-end solutions built on HPE's Enterprise Portfolio of products and services.

**5 Bryan Gurley** is an HPE Master Enterprise Architect and technology strategist who has worked for and with some of the largest Global and Enterprise business institutions in the world. As a technology strategist his focus is on sharing HPE's technology strategy and helping customers identify, design, and deploy complex IT and business solutions representing the entire HPE portfolio of products and services.

**5 Patrick Atkins** is an Enterprise Solutions Architect with the HPE Northeast team specializing in the design, sizing, and tuning of complex infrastructure and application solutions. He has contributed to the HPE Synergy chapter in this book.

**6 Vikram Fernandes** is a Distinguished Technologist who is specialized in architecting and implementing software-defined infrastructure. He contributed to one chapter in this book.

**7 Andy Scheferman** has been a Storage Ambassador with Hewlett Packard Enterprise (HPE) for the last 10 years. He has been in presales for 27 years, in the storage industry for 25 years, and has served as the HPE Lead Storage Ambassador for North America for the past 4 years. He was recently promoted to Enterprise Storage SA Manager for HPE in the NY Metro area.

**8 Bill Hill** is an experienced technology leader at HPE in the enterprise storage Business Unit. He is focused on all aspects of Storage technologies, specializing in SAN, NAS, scale-out architectures, and integration of our storage portfolio into our Hybrid IT strategy.

**9 Delvon Jones** is an Account Chief Technologist (ACT) responsible for exceeding customer objectives with a long-term strategy, vision, and technology. In addition to being an ACT, he is a Distinguished Technologist, a title bestowed by the global board of directors, and reserved for HPE's top talent.

**10 Matt Maccaux** has been working with customers across many industries for the past 20 years at some of the biggest technology companies in the world. For the past 8 years, he has focused on the application modernization and advanced analytics space, helping customers define and implement enterprise-wide programs to accelerate their time to market using modern technologies. In his current role as the Global Field CTO for HPE Enterprise Software, he is working with executives to develop roadmaps and strategies for their next-generation analytics using AI/ML/DL and cloud-native applications to help those organizations provide those capabilities as-a-Service to the enterprise.

**10 Tom Phelan** is an HPE Fellow and CTO for the HPE Container Platform. He joined HPE when BlueData, Inc was acquired in 2018. He was Co-founder and Chief Architect of BlueData. Previously, he has had a long engineering career with VMware, Silicon Graphics, Stratus, and other Silicon Valley companies.

**10 John Gromala** is Senior Director of Portfolio Strategy within the Hybrid IT Office of the CTO. He joined HPE from Compaq and held previous roles leading global product strategy, product management & marketing for ProLiant, BladeSystem, Apollo, Moonshot, and Cloudline product.

**11 Erik Vogel** is Vice President of Customer Experience HPE GreenLake. He is responsible for understanding clients' needs, identifying areas of opportunity to improve the overall customer experience, and identifying areas for investment to create innovative solutions. He is also responsible for enabling delivery teams and partners to scale solutions.

**12 and 13: Main Author Nick Harders** is an SE Director for Global/Major Accounts at Aruba. He leads a team of Systems Engineers (SEs) and SE Managers (SEMs) covering the North America region. He resides in the NYC Metro area and has a personal interest in cloud, network programmability, and orchestration.

**12 Jeff Olson** is a Senior Solutions Marketing Manager responsible for Aruba's Software-Defined Branch solution. Prior to joining Aruba, he led Product Marketing for Mojo Networks, a cloud-managed Wi-Fi startup. Previously, he held a broad range of corporate positions including product marketing, product management, sales enablement, and software engineering.

**12 Alan Sardella** is on the Product Management team at Aruba, focusing on SD-WAN and SD-Branch. His 20 years in the networking industry has encompassed a wide variety of traditional and software-defined networking solutions. Prior to Aruba, he worked in software development, support, and training.

**13 Sue Gillespie** is the senior product marketing manager for enterprise switching at Aruba. She is responsible for guiding and developing GTM positioning, marketing launches, and communications for Aruba's amazing switching portfolio.

**13 Mason Coffman** is a product marketing manager for campus switching at Aruba. He has over 10 years of diverse marketing experience, with a heavy emphasis on content marketing and related practices. He has a background in journalism and has covered a variety of technology trends including cloud, mobile, DevOps, and IoT. Based in Kansas City, Missouri, he is an avid hiker and general sports enthusiast.

**13 Dave Chen** is a Senior Product Marketing Manager at Aruba, specializing in enterprise cloud networking solutions. Over the course of his career, he has held a variety of positions encompassing product, sales, and enablement at Hewlett Packard and Aruba Networks. He graduated from the University of California, Berkeley with a degree in Political Science.

**14 Ashish Kumar** is Data and Solutions architect focussed on developing Big Data and Analytics Solutions Reference Architecture and specializes in Real-Time Streaming Analytics and In-Memory Graph Analytics.

**14 Steve Tramack** is a Director of Engineering for Database and Analytics solutions, focusing on big and fast data analytics, AI and ML Ops, as well as traditional RDBMS and Analytics for large-scale enterprise solutions.

**14 David J Furtzaig** is a Financial Services Industry Chief Technical Strategist and Technologist, focusing on Public/Private/Hybrid Clouds, large-scale enterprise solutions and technology simplification.

**15 Tom Golway** is a Chief Technologist at HPE, focused on providing business and technical thought leadership to help customers realize their business strategies. His primary focus has been in working with customers on innovative use cases for emerging technologies such as Blockchain, Deep Learning, and Memory Driven Computing.

**16 Simon Thomason** assists enterprise customers to design and build infrastructure solutions for a wide variety of applications and workloads, most recently focusing on HPE's industry-standard server product lines, Artificial Intelligence, and is pursuing a master's degree in Leadership and Sustainability.

**17 Steve Scargall** is a Persistent Memory Software and Cloud Architect at Intel Corporation. He supports the enabling and development effort to integrate persistent memory technology into software stacks, applications, and hardware architectures. This includes working with independent software vendors (ISVs) on both proprietary and open source development, original equipment manufacturers (OEMs), and cloud service providers (CSPs).

**18 Gary Allard** is a Senior Solution Architect at HPE, focused on server and storage solutions in the state government, local government, education, and healthcare industries.

**18 Vinny Aniano** is an HPE Solution Architect supporting large enterprise accounts, primarily in the Financial Services Industry.

**18 Ryan Gardiner** is an HPE Enterprise Architect supporting enterprise acquisition accounts across all vertical industries.

**18 Patrick Greene** is a Master HPE Enterprise Architect supporting Large Enterprise and Global accounts. Patrick has focused on High Performance Computing and Big Data Analytics solutions for Life Sciences / Pharmaceutical and Financial Services accounts. Patrick is a frequent presenter at HPE's Executive Briefing Center in NYC.

**19 Kurt Lacy** is a Hybrid Chief Technologist, focused on strategic customer engagements to articulate the value of Hybrid IT and Digital Transformation.

# CONTENTS

---

<b>1 Accelerate AI Adoption with HPE.....</b>	<b>1</b>
Introduction .....	1
AI Overview .....	2
Machine Learning and Deep Learning .....	2
The Evolution of Systems.....	3
The Storage Problem.....	5
HPE’s Elastic Platform for Analytics .....	7
AI made EASY.....	8
The HPE Container Platform .....	9
HPE’s Deep Learning Cookbook .....	11
HPE’s AI Portfolio .....	13
Summary.....	14
References .....	14
<b>2 The Power of Connection: The Internet of Things .....</b>	<b>15</b>
Introduction .....	15
The Evolution and Opportunity for IoT at the “Edge” .....	16
A Strategic Approach and Framework for IoT .....	20
IoT Technologies.....	22
Sensors .....	22
Connectivity and Data Retrieval .....	22
Processing, Control, and Management .....	25
HPE Edgeline Systems Management Strategy .....	28
Security.....	29
Services .....	30
Edge-to-Core Analytics and Use of AI Within IoT.....	31
OT and IT Data and Analytics Integration.....	33
Industry Use Cases .....	34
Real-time Collaboration.....	34
Manufacturing.....	35
Video Analytics .....	35
Retail .....	36
Food Service .....	37
The Future Potential of IoT .....	38

<b>3</b>	<b>Consumption-based Management on Your Terms</b> .....	<b>41</b>
	Introduction .....	41
	Consumption-based IT Simplified.....	42
	HPE GreenLake Solutions .....	44
	Operational Aspects of HPE GreenLake .....	45
	GreenLake Central .....	46
	How Consumption Data Drives Value.....	52
	Sample Design for a Consumption-based Model.....	55
	Summary.....	58
<b>4</b>	<b>OneView Integration</b> .....	<b>61</b>
	Introduction .....	61
	RESTful-based Industry Solutions .....	62
	How HPE OneView Is Deployed .....	62
	How HPE OneView Works .....	63
	A Single Unified Workflow .....	63
	Example of HPE OneView's Integration with Ansible .....	64
	HPE OneView and Support of Industry Standards.....	67
	Summary.....	67
<b>5</b>	<b>HPE Synergy and Composable Infrastructure</b> .....	<b>69</b>
	Introduction .....	69
	HPE Composable Infrastructure .....	70
	Synergy 12000 Frame and Components .....	71
	Synergy Use Case Examples .....	76
	Solution Overview 1 .....	79
	Solution Overview 2.....	81
	Summary.....	84
<b>6</b>	<b>Integrate Next-Gen Tools into HPE OneView</b> .....	<b>85</b>
	Introduction .....	85
	Enterprise Monitoring Landscape.....	85
	OneView-Nagios Integration .....	86
	OneView-Splunk Integration .....	88
	OneView-ServiceNow Integration .....	90
	OneView Global Dashboard.....	93
	Summary.....	94
<b>7</b>	<b>Demystifying Software-Defined Storage (SDS)</b> .....	<b>95</b>
	Introduction: What Is Software-Defined Storage? .....	95

System-Defined Versus Software-Defined.....	96
Overview of SDS Types.....	97
Block storage.....	97
File-based storage .....	98
Object storage.....	99
Backup/Archive Systems .....	100
Scale-out storage .....	101
Hyper-Converged Infrastructure .....	102
Examples from the HPE Storage Portfolio .....	103
Datera Block Storage .....	103
Qumulo Scale-Out General Purpose NAS.....	105
WekaIO—High-Performance NAS .....	107
Scality Ring—SDS Object Storage.....	108
SUSE Enterprise Storage—Ceph .....	109
Cohesity.....	112
SimpliVity.....	113
Disaggregated Hyper-Converged Infrastructure (dHCI).....	114
Conclusion .....	116
Sources .....	116
<b>8 System-Defined Storage.....</b>	<b>119</b>
Introduction .....	119
Intelligent Data Platform.....	119
System-Defined Storage Platforms .....	121
Mission-Critical Workloads.....	121
Business-Critical and General Purpose Workloads .....	122
Virtualized Workloads .....	122
Secondary Workloads.....	122
HPE Primera 600 Storage.....	123
HPE 3PAR 8000, 9000, 20000 Storage .....	124
HPE Nimble Storage .....	125
HPE InfoSight.....	126
Summary.....	128
<b>9 Implement your Cloud Strategy using a Cloud Management Platform.....</b>	<b>129</b>
Introduction .....	129
Cloud Management Platform (CMP).....	130
Automation and Orchestration Capabilities.....	131

How long does it take for your organization to deploy a full application stack today? .....	131
What is the source of the delay? .....	131
Experience True Automation .....	133
The Ability to Discover Assets .....	143
Security Integration .....	144
Summary.....	145
<b>10 HPE Container Platform Introduction.....</b>	<b>147</b>
Introduction .....	147
HPE Container Platform Basics .....	147
HPE Container Platform GUI .....	150
Summary.....	154
<b>11 Workload Analysis for the Cloud.....</b>	<b>155</b>
Introduction .....	155
Assessment Considerations .....	156
Assessment Results .....	157
Summary.....	161
<b>12 Aruba Software-Defined Branch (SD-Branch) .....</b>	<b>163</b>
SD-BRANCH SOLUTION OVERVIEW .....	163
Introduction .....	163
The Software-Defined Branch.....	164
Best-in-Class LAN Infrastructure .....	164
The SD-WAN Gateways.....	164
Cloud-Managed Simplicity and Scale .....	165
Integrated, Best-in-Class Security.....	166
Cloud-Based Security Partners .....	167
An Optimized Branch Experience.....	167
Summary .....	167
OPTIMIZING SOFTWARE AS A SERVICE (SAAS) .....	168
Introduction .....	168
How SaaS Express Works.....	168
Example: Finding the Best Path for a SaaS Application .....	169
Network-Wide Visibility for all Critical SaaS Applications.....	171
Conclusion .....	173
DYNAMIC PATH STEERING WITH SERVICE-LEVEL AGREEMENTS .....	174
Introduction .....	174
Sample DPS Scenario.....	174
Using Probes and Measuring Path Quality .....	176

Configuration Steps for Application-Based Policies .....	176
Monitoring Path Steering .....	179
Monitoring Application Performance .....	180
Conclusion .....	182
<b>SEAMLESS SD-WAN ORCHESTRATION .....</b>	<b>183</b>
<b>Introduction .....</b>	<b>183</b>
About the Aruba SD-WAN Orchestrator .....	183
Examples: Orchestrating an SD-WAN Overlay Network .....	187
Conclusion .....	190
<b>UNIFIED POLICY AND MANAGEMENT FOR THE DISTRIBUTED ENTERPRISE .....</b>	<b>191</b>
<b>Key Benefits .....</b>	<b>191</b>
Traditional LAN Segmentation .....	191
Branch Office Management .....	192
Role-Based Policy for the Distributed Enterprise .....	196
Mechanisms for Role-Based Access and Policies .....	197
The Gateway's Role in Policy Enforcement .....	197
Extending Role-Based Policies to the WAN .....	199
Conclusion .....	200
<b>Reference Documentation .....</b>	<b>201</b>
Solution Overview .....	201
Technical Document .....	201
Technology Brief .....	201
Technology Brief .....	201
Technical Document .....	201
<b>13 Aruba Switching (AOS-CX) .....</b>	<b>203</b>
<b>ARUBA CX SWITCHING .....</b>	<b>203</b>
<b>Introduction .....</b>	<b>203</b>
Key Benefits .....	204
Network Challenges .....	204
Aruba's CX Switching Solution .....	205
Aruba Dynamic Segmentation .....	207
Data Center, Campus, and Branch .....	208
<b>ARUBA NETWORK ANALYTICS ENGINE .....</b>	<b>209</b>
<b>Introduction .....</b>	<b>209</b>
Key Benefits .....	210
From Problem to Root Cause .....	210
NAE Components .....	210
Example Use Cases .....	212
Integration with NetEdit for Added Management Simplicity .....	215

Community Development .....	215
Conclusion .....	215
ARUBA NETEDIT .....	216
Introduction .....	216
How NetEdit Works .....	217
Key Capabilities .....	218
Conclusion .....	220
ARUBA DYNAMIC SEGMENTATION .....	221
Introduction .....	221
Key Business and Technical Drivers .....	221
Extending WLAN Innovations to Switching .....	222
The Solution Ingredients .....	224
Conclusion .....	224
ARUBA VIRTUAL SWITCHING EXTENSION (VSX) .....	225
Introduction .....	225
No Downtime, Even During Upgrades .....	226
A Better Way to Achieve High Availability .....	227
Alternative Approaches .....	228
Flexible Design Options .....	229
Conclusion .....	229
REFERENCE DOCUMENTATION .....	230
Solution Overview .....	230
Solution Overview .....	230
Data Sheet .....	230
Solution Overview .....	230
Technology Brief .....	230
<b>14 Meet Cybersecurity and Data Analytics Needs with Memory-Driven Computing.....</b>	<b>231</b>
Challenges with Growing Volumes of Data .....	231
In-Memory Analytics Use Cases .....	233
Key Features of In-Memory Analytics .....	234
Case Study: Cybersecurity analytics for a financial services organization .....	236
Summary .....	238
References .....	239
<b>15 Unleash Innovation with Cloudless Computing .....</b>	<b>241</b>
Introduction .....	241
Consumption Models .....	241

System of Record .....	242
System of Engagement .....	242
System of Action .....	243
Application Architectures .....	243
The Data Revolution .....	245
Today's Hybrid Cloud Reality.....	245
The HPE Cloudless Vision.....	247
The Journey.....	247
Key Tenets .....	249
The HPE Cloudless Architecture .....	249
Cloudless Fabric .....	249
Trust Fabric (Security) .....	250
Connectivity Fabric (Optimization) .....	251
Value Fabric (Openness).....	252
Summary: The HPE Vision for Composable Fabric .....	252
<b>16 Improve Sustainability with HPE Circular Economy .....</b>	<b>255</b>
Introduction .....	255
Circular Economy.....	256
Summary: HPE's Sustainable Solutions .....	259
<b>17 Persistent Memory: Moving data closer to the CPU .....</b>	<b>261</b>
Introduction .....	261
The Definition of Persistent Memory .....	261
How did we get here? .....	263
The Memory and Storage Hierarchy .....	264
Latency at a Human Scale.....	266
I/O Latency Improvements Require System Innovation .....	267
Using Persistent Memory.....	270
Operating System Support for Persistent Memory .....	273
Virtualization and Persistent Memory.....	273
Increasing Virtual Machine Density .....	274
Directly Accessing Persistent Memory from the VMs.....	274
Virtual Machine Migration.....	274
VMware vSphere/ESXi .....	275
Microsoft Hyper-V.....	275
KVM/QEMU .....	276
Kubernetes and Docker .....	277
Application Support for Persistent Memory.....	278
An Opportunity for Software Developers .....	278

Persistent Memory in the Real World .....	279
Aerospike.....	279
KX Systems.....	281
Microsoft SQL Server 2019 .....	282
Oracle .....	283
Summary.....	284
<b>18 HPC for AI and Deep Learning .....</b>	<b>285</b>
Introduction .....	285
The HPE Compute Family.....	285
Pensando .....	288
<i>Benefit #1: Granular Security</i> .....	288
<i>Benefit #2: Higher Performance</i> .....	288
<i>Benefit #3: Improved Uptime</i> .....	288
<i>Benefit #4: Lower Total Cost of Ownership</i> .....	289
An Example Design for HPC for AI and Deep Learning .....	289
Solution Overview.....	290
How Did We Arrive At This Solution?.....	291
Server Power .....	292
Server Cooling .....	293
Hardware Inventory .....	293
Implementation Project Plan .....	294
Solution Validation and Success Criteria .....	295
Looking Ahead .....	295
<b>19 The Power of Azure in your Data Center:</b>	
<b>Microsoft Azure Stack Hub and HCI .....</b>	<b>297</b>
Introduction .....	297
The Azure and Azure Stack family .....	297
Microsoft Azure Stack Hub .....	298
Azure Stack Hub Use Cases.....	298
HPE ProLiant for Microsoft Azure Stack Hub solution.....	300
Microsoft Azure Stack HCI.....	303
Azure Stack HCI Scenarios .....	303
HPE Azure Stack HCI solutions.....	303
Summary.....	308
<b>Index.....</b>	<b>309</b>

# 1 Accelerate AI Adoption with HPE

## INTRODUCTION

Intelligence is everything and the age of AI and algorithmic business is here to stay. The artificial intelligence (AI) field has been around for close to a century but only in the last several years has it become the biggest technology headliner and most likely will be for the foreseeable future. AI is disrupting and transforming all industries, increasing automation from financial services to manufacturing, and creating new business models from retail to transportation.

The massive explosion of digitized data from the sensory edges and the Internet of Things (IoT) are feeding this acceleration of AI. IoT with edge computing has fueled this path to AI with creation of variants of machine learning algorithms required to automate and solve problems. Algorithmic platforms are being created overnight and what humans can do today can very well be done now through machines with the ability to handle menial tasks while taking on more complex actions as more algorithms become available. Insights from data are being gained from it being moved and fed into deep learning neural networks processed via core data centers and/or cloud and these new algorithms are created and moved to the various IT and OT Edges for inference and action. This infinite data loop—data pipeline (Figure 1-1) created is enabling faster time to insights for automation and the ultimate nirvana is for real-time decision making across every fabric of everyday life.

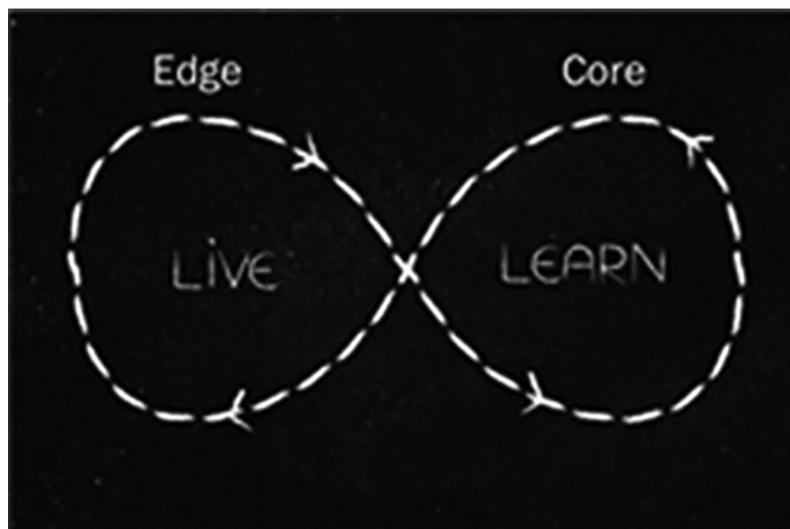


Figure 1-1 Infinite Data Loop

## AI Overview

What are the elements of artificial intelligence, where is it going, and how is HPE creating unique differentiation to enabling these emerging technologies? Due to the constant information flow on AI, what AI is and what AI can do today may be confusing. The most basic definition of AI is that it is a field in computer science that makes machines seem like they have human intelligence, enabling machines to solve problems, complete tasks, and have human-like cognitive futures. Of course, this broad context of AI adds confusion as to what level of AI interacts with the world today. For example, the Alexa personal assistant that many have in their homes can be considered Artificial Narrow Intelligence (ANI) or “weak AI”—AI that is programmed to do a single task. ANI systems pull from single data sets to perform specific tasks such as checking the weather, report the news, or play Chess or Go strategy games.

Narrow/weak AI still lacks the ability to have human-like intelligence, self-consciousness, or think for themselves which is considered artificial general intelligence (AGI). The science fiction movie Terminator and the Starnet artificial neural network system is still far from reach today and those that have more of a fatalist attitude believe that this is eventually where AI will be headed. AGI or “strong” AI still has ways to go however with the acceleration of the various types of data feeding various AI engines, there will be a time with general/strong AI, advancement in robotics, and security to enable potential sentient beings or the ultimate AI which is Super Intelligence (ASI). This is still a bit of science fiction that is becoming more and more reality as the decades move on.

## Machine Learning and Deep Learning

The two key sub areas of AI are Machine learning (ML) and Deep learning (DL). ML refers to a set of algorithms that learn from examples in specific data sets. DL, on the other hand, is an exciting new area and is a sub-category of Machine Learning where the relevant attributes or features necessary are learned in an automated fashion by the model especially for unstructured data-like text, photos, videos, and so forth. Figure 1-2 provides an overview of both areas.

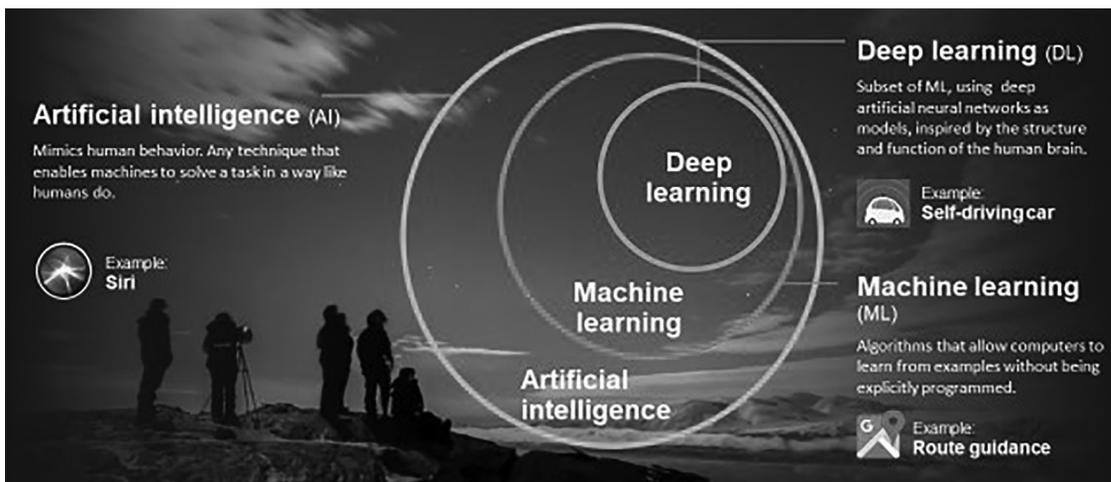


Figure 1-2 Machine Learning and Deep Learning

Under ML, algorithms are fed data with specific fields, also referred to as features that are used to create a model. Thereafter this model can predict the results based on new data that is fed to it. A few basic examples are classification whether an email is spam or not based on training that was done on a wide bunch of emails. Or is this product, a movie or clothing based on a set of transactions. Or what will be the temperature in San Jose tomorrow based on prior data that is fed into a model.

DL utilizes a hierarchical level of artificial neural networks similar to how the human brain is built to carry on the process of learning. A classic example of DL is where a model is able to distinguish between a dog and a cat after being fed thousands of photos of cats and dogs. DL also has applicability in areas such as self-driving or smart cities, and ML is used in popular daily used products such as Google Maps.

## The Evolution of Systems

From a systems perspective, the common theme here is the need for more data. The ML and DL modeling require a massive amount of data to ensure accurate predictions and ultimately real-time decision making. With the constant influx of growing data across all mediums, ML/DL engines have plenty to feed from. But how does all this data turn into action and insight? Some say data is the new gold or oil; the only difference is that the amount of data is not finite but infinite. Figure 1-3 illustrates how HPE Labs looks at the next step in this evolution from Systems of Record to Engagement to a new paradigm, Systems of Action.

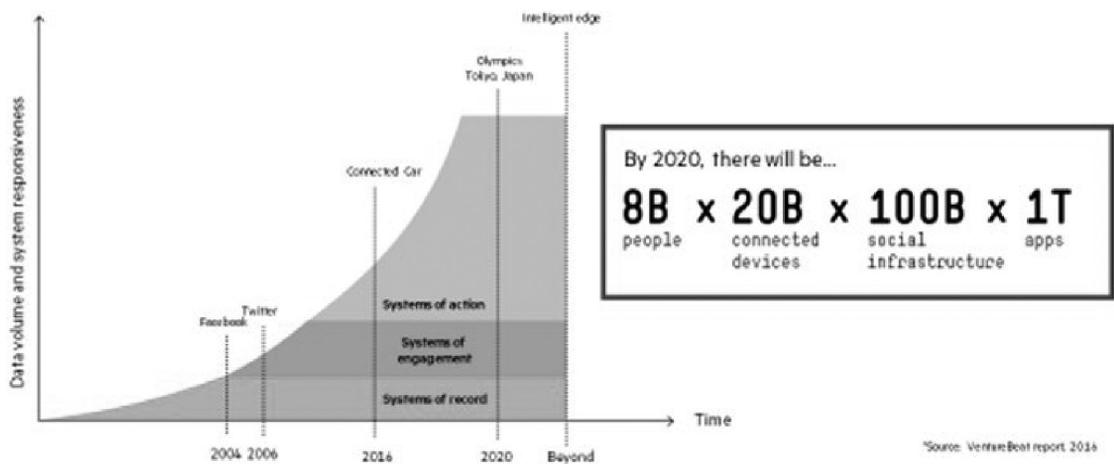


Figure 1-3 Systems of Record, Engagement, and Action

## Systems of Record

For many years, computing was all about processing structured records. Structured records are man-made constructs that capture the data elements and information that is the authoritative data source from which the information can be re-represented for specific uses. Computerized structured