

Table of Contents

Foreword by Dr. Rahul Razdan	xiv
Foreword by Daniel Watzenig	xvi
Preface and Acknowledgments	xviii

SECTION 1 – Introduction

CHAPTER 1

Introduction	3
1.1. FIR and the Automotive Industry	3
1.2. ACES as the Future Mobility	4
1.3. Objectives of the Book	6
1.4. Expectation and Contribution of the Book	7
1.5. Overview and Outline	8
1.6. Summary	9
References	9

SECTION 2 – ACES as the Future Mobility: Background

CHAPTER 2

Recent Events and Progress Propelling ACES Growth	15
2.1. Advanced Driver Assistance Systems and Vehicle Automation	16
2.2. Active Safety and the Safety Benefits	17
2.3. Software-Defined Vehicles	18
2.4. Fourth Industrial Revolution	19
2.5. United Nations Sustainable Development Goals	19
2.6. Society 5.0	20
2.7. Climate Change and Intergovernmental Panel on Climate Change 2021 Report	20
2.8. Carbon-Neutral and Finite Petroleum Resources	22
2.9. Green, Circular, and Sustainable Economy	23
2.10. Sharing Economy	23
2.11. Regulations Facilitating ACES	24
2.12. IoT and 5G	24
2.13. Advances in Computing Power and Platforms	25
2.14. Sensor Advancements (LiDAR, RADAR, Camera)	26
2.15. Cross-Functional Software Product Development and Change Management	28
2.16. Silicon Valley and Rise of Start-Ups	28
2.17. X-as-a-Service	29
2.18. Acqui-Hiring and M&A	30
2.19. Supply Chain Evolutions	31

2.20. Digital Natives	31
2.21. Summary	32
References	32

SECTION 3 — Concise Overview of ACES

CHAPTER 3

Autonomous Vehicles: Concise Overview	41
3.1. Background and What	41
3.2. Technical Overview	43
3.2.1. How Humans Operate: An Anecdote to Simplify the AV Back-End Algorithms	43
3.2.2. Human-Operated Vehicles Operation	44
3.2.3. AV Stack in General	46
3.2.4. Mapping and Localization	47
3.2.5. Environmental Awareness	48
3.2.6. Risk Assessment	50
3.2.7. Motion Planning	52
3.2.8. Motion Control	54
3.2.9. Interface, Calibration, and Monitoring	55
3.3. Vision and Current State of the AV Industry	56
3.4. Summary	58
References	58

CHAPTER 4

Connected Vehicles: Concise Overview	65
4.1. Background	65
4.2. Connecting and Connected	67
4.3. Back-End Overview	68
4.3.1. Vehicular Ad Hoc Network	68
4.3.2. Cloud Technology	69

4.3.3. Dedicated Short-Range Communications	69
4.3.4. Cellular Vehicle-to-Everything (C-V2X)	70
4.3.5. Low-Power Wide-Area Network	71
4.3.6. 5G and Its Importance for Vehicle Connectivity	71
4.3.7. A Glimpse of 6G, the Probable Next Step in the Vehicle Connectivity Field	72
4.4. Applications	73
4.4.1. Vehicle-to-Everything	73
4.4.2. Vehicle Connectivity for Improved Active Safety	74
4.4.3. Vehicle Platooning	75
4.4.4. Improved Infotainment	76
4.4.5. Improved GPS and Traffic Jam Reduction	76
4.4.6. Vehicle Connectivity Enabling Automated Delivery	77
4.4.7. Vehicle Connectivity Improving Shared Mobility	77
4.5. Vehicle Connectivity Roles in Enabling True ACES Mobility	78
4.6. Vision and Current State of the CV Industry	79
4.7. Summary	80
References	80

CHAPTER 5

Electric Vehicles: Concise Overview	87
5.1. Background	87
5.2. Electrifying the World—The Motivation	90
5.3. Back-End Overview	92
5.3.1. Hybrid Electric Vehicles	92
5.3.2. Plug-In Hybrid Electric Vehicles	95
5.3.3. Battery Electric Vehicles	96
5.3.4. Fuel Cell Electric Vehicle	98
5.3.5. Solar EVs	100

5.4. Vehicle Electrification Roles in Enabling True ACES Mobility	101
5.5. Vision and Current State of the EV Industry	101
5.6. Summary	102
References	102

CHAPTER 6

Shared Mobility: Concise Overview	107
6.1. Background	107
6.2. Motivations behind Shared Mobility	108
6.2.1. Sharing Economy	108
6.2.2. Uberization	110
6.2.3. X-as-a-Service	110
6.3. Terminology and Definition: Clarification and Difference	111
6.3.1. Shared Mobility	112
6.3.2. Carsharing	112
6.3.3. Carpooling	112
6.3.4. Ridesharing	113
6.3.5. Ridehailing	114
6.3.6. Ridesourcing	114
6.3.7. Micromobility	114
6.3.8. Paratransit	115
6.3.9. Microtransit	115
6.3.10. Other Types of Shared Mobility	116
6.4. Differences between “Traditional Taxi” and “Shared Mobility”	116
6.5. Customer-and-User-Facing Technology Development for Shared Mobility	116
6.6. Roles of Shared Mobility in the ACES Ecosystem	117
6.7. Summary	119
References	120

SECTION 4 – Disruptions, Challenges, and Benefits of ACES

CHAPTER 7

Disruptions Caused by ACES	
Mobility	125
7.1. Background	125
7.2. Social Disruptions	125
7.2.1. Work-Life Balance Improvements	126
7.2.2. Disruptions for Media and Infotainment	126
7.2.3. Merging with the Other Industrial Revolution 4.0 Ongoing Developments	128
7.2.4. Redefining Mobility	128
7.2.5. Disrupting Future Urban Planning	128
7.3. Legal, Economical, and Workforce Disruptions	130
7.3.1. Insurance Industry	130
7.3.2. Taxations	130
7.3.3. New Required Skills for Workforce	131
7.3.4. New Job Ecosystems Opportunities	132
7.3.5. Who Will Have the Ownership of ACES Vehicles?	132
7.3.6. Indirect Influence on Popular Culture	132
7.3.7. Passenger Behavior during the ACES Journey	133
7.3.8. Regulations... and More Regulations	133
7.3.9. Private-Public-People Partnerships	134
7.3.10. Increased Requirements of Empathy from the Leaders to Employees	135
7.4. Technical, Technological, and Industrial Disruptions	135
7.4.1. ACES Increases the Software Importance in the Automotive and Mobility Industry	136
7.4.2. Changes in the Business Models	136
7.4.3. Process and Regulations Changes	136
7.4.4. Infrastructural Disruptions	137
7.4.5. New Automotive and Mobility Industrial Stakeholders	138

7.4.6. Democratizing Mobility	138
7.4.7. New Incomes for Countries	138
7.4.8. Skunkworks Project-Organizations	138
7.4.9. More Concentrated Efforts to Tackle Climate Change Issues	139
7.5. Summary	139
References	140

CHAPTER 8

Potential Challenges of ACES	145
8.1. Background	145
8.2. Technical Challenges of ACES	146
8.2.1. Dealing with Uncertainties	146
8.2.2. Network Latency	147
8.2.3. Cybersecurity	147
8.2.4. Range Anxiety Is Still an Issue	147
8.2.5. Infrastructural Improvements to Support Vehicle Electrification	148
8.2.6. Battery Recycling and Waste Management	148
8.2.7. Hygiene Topics	148
8.2.8. Ridesharing and Traffic Jams	149
8.2.9. Traveling Salesman Problem	150
8.3. Legal, Industrial, and Workforce Challenges of ACES	150
8.3.1. Vandalism and Petty Crimes	150
8.3.2. Whose Fault Is It? Who Is to be Blamed?	150
8.3.3. Scope Creep and Technical Debt in the Software Development	151
8.3.4. Pricing Is Still Expensive	151
8.3.5. Unclear Requirements because of the Knowledge Gap in the Business-Facing Organizations	152
8.4. Social and Ethical Challenges of ACES	153
8.4.1. Changing Job Landscapes	153
8.4.2. Transparency Is Needed	153

8.4.3. Requirement for a Visionary and Skillful Public Leadership 154

8.4.4. Importance of Education and Propagations 154

8.4.5. False and Misleading Marketing 154

8.5. Summary 155

References 156

CHAPTER 9

Potential Benefits of ACES 159

9.1. Technological, Safety, and Security Benefits 159

9.1.1. Prompting Safer Automation in Other Industries 160

9.1.2. Encouraging ACES Mobility across Different Transportation Domains 160

9.1.3. Increased Safety 161

9.1.4. More Transparency and Security for Mobility 163

9.2. Societal and Sustainability Benefits 164

9.2.1. Lessened Car Ownership: A Chance to Reimagine Mobility 164

9.2.2. Cleaner Mobility Ecosystem and Energy 165

9.2.3. Improved Traffic in Cities 165

9.2.4. More Spaces for Urban Recreational Zones and Activities: Improving the City Attractiveness 166

9.2.5. Less Stress for City Dwellers 167

9.2.6. Potential to Reduce Crimes 167

9.2.7. Better Social Security Benefits 168

9.2.8. Facilitating Some Objectives of the UN SDGs 169

9.2.9. Improving Air Quality, Improving Health 170

9.3. Mobility User Benefits 171

9.3.1. Better Transportations for the Society 171

9.3.2. Reduced Costs of Transportation 172

9.4. Economic Benefits 172

9.4.1. New Investments Potential 172

9.4.2. Opportunities for Developing Countries 173

9.4.3. New Business Models	173
9.4.4. Cross-Collaborations between Different Industries	174
9.5. Summary	174
References	174

SECTION 5 – Summary and Conclusions

CHAPTER 10

Summary: “ACES Is Imminent. It Is a Bumpy Road. Cross-Organizational Collaborations Are a Necessity.”	179
10.1. Recapitulating the Book	180
10.2. Summary for Section 1—Introduction	181
10.3. Summary for Section 2—ACES as the Future Mobility: Background	181
10.4. Summary for Section 3—Concise Overview of ACES	182
10.5. Summary for Section 4—Disruptions, Challenges, and Benefits of ACES	182
10.6. Required Future Efforts for ACES Mass Deployment	183
10.6.1. Technical	183
10.6.2. Legal	183
10.6.3. Social	184
10.6.4. Process and Procedures	185
10.7. It Is a Bumpy Road, But It Is Not Impossible	185
10.8. The Dream and Hope for This Book	186
10.9. Summary and Conclusion	187
References	187
Index	189
About the Author	193