FROST & SULLIVAN



Benchmarking of European OEM Software-defined Vehicle Strategies, 2024

Transformative Megatrends Forcing European OEMs to Focus on Pre-competitive Collaboration at a Deeper Level Across their Ecosystem; Previously Unseen in the Automotive Industry

Global Automotive & Transportation Research Team at Frost & Sullivan

PFM2-46
August 2024

© 2024 Frost & Sullivan. All rights reserved. This document contains highly confidential information and is the sole property of Frost & Sullivan.
No part of it may be circulated, quoted, copied, or otherwise reproduced without the written approval of Frost & Sullivan.

Contents

Section	Slide Number
Growth Environment	7
• Key Findings	8
• Comparative Analysis: OEM Hardware Strategy	10
• Comparative Analysis: OEM Software Strategy	11
• Comparative Analysis: SDV Strategy & Implementation	12
Transformation in the Software-Defined Vehicle Sector	13
• Why Is It Increasingly Difficult to Grow?	14
• The Strategic Imperative 8™	15
• The Impact of the Top 3 Strategic Imperatives on the Benchmarking of European OEM Software-defined Vehicle Strategies	16
Ecosystem	17
• Research Scope	18
• Growth Drivers	19
• Growth Restrains	20
• Segmentation	21
• Key Competitors	22

Contents (continued)

Section	Slide Number
Software-defined Vehicle Strategy: BMW	23
• BMW Hardware Strategy	24
• Potential List of BMW Models on New Architecture	25
• BMW Software Development Strategy	26
• BMW Software Platform	27
• BMW Focus Areas, SDV Ecosystem, & Strategy	28
Software-defined Vehicle Strategy: Mercedes-Benz	29
• Mercedes-Benz Hardware Strategy	30
• Potential List of Mercedes-Benz Models on New Architecture	31
• Mercedes-Benz Software Development Strategy	32
• Mercedes-Benz Software Strategy: MB.OS Platform	33
• Mercedes-Benz Focus Areas, SDV Ecosystem & Strategy	34
Software-defined Vehicle Strategy: Renault-Nissan-Mitsubishi	35
• Renault-Nissan-Mitsubishi Hardware Strategy*	36
• Potential List of RNM Models on New Architecture	37

Contents (continued)

Section	Slide Number
• RNM Software Development Strategy	38
• RNM Software Strategy: Software Platform	39
• RNM Focus Areas, SDV Ecosystem & Strategy	40
Software-defined Vehicle Strategy: Stellantis	41
• Stellantis Hardware Strategy: STLA Architecture	42
• Stellantis Software Development Strategy	44
• Stellantis Software Strategy	45
• Stellantis Focus Areas, SDV Ecosystem & Strategy	46
Software-defined Vehicle Strategy: Volkswagen	47
• Volkswagen Hardware Strategy	48
• Potential List of Volkswagen Models on New Architecture	49
• Volkswagen Software Development Strategy	50
• Volkswagen Software Strategy: VW.OS Software Platform	51
• Volkswagen Focus Areas, SDV Ecosystem & Strategy	52

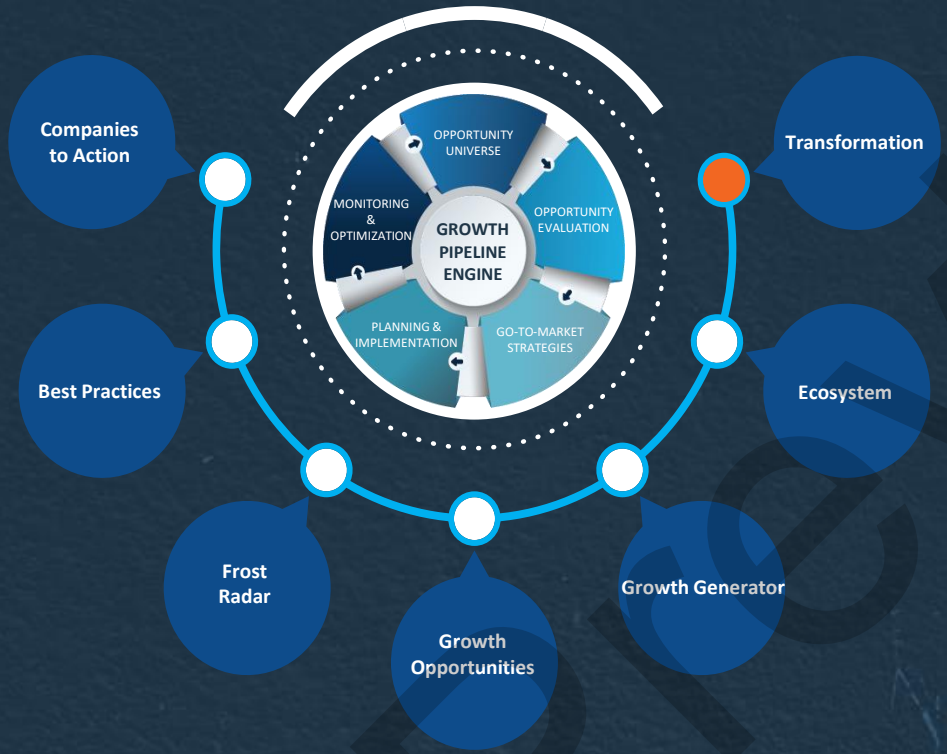
Contents (continued)

Section	Slide Number
Software-defined Vehicle Strategy: Volvo	53
• Volvo Hardware Strategy	54
• Potential List of Volvo Models on New Architecture	55
• Volvo Software Development Strategy	56
• Volvo Software Strategy: VolvoCar.OS Software Platform	57
• Volvo SDV Ecosystem & Strategy	58
Growth Opportunity Universe	59
• Growth Opportunity 1: Evolving Ecosystem	60
• Growth Opportunity 2: FoD Business Model	62
• Growth Opportunity 3: Pan-industry Collaboration	64
Best Practices Recognition	66
• Best Practices Recognition	67
Frost Radar	68
• Frost Radar	69

Contents (continued)

Section	Slide Number
Next Steps	70
• Benefits and Impacts of Growth Opportunities	71
• Next Steps	72
• Take the Next Step	73
• List of Exhibits	74
• Legal Disclaimer	75

FROST & SULLIVAN



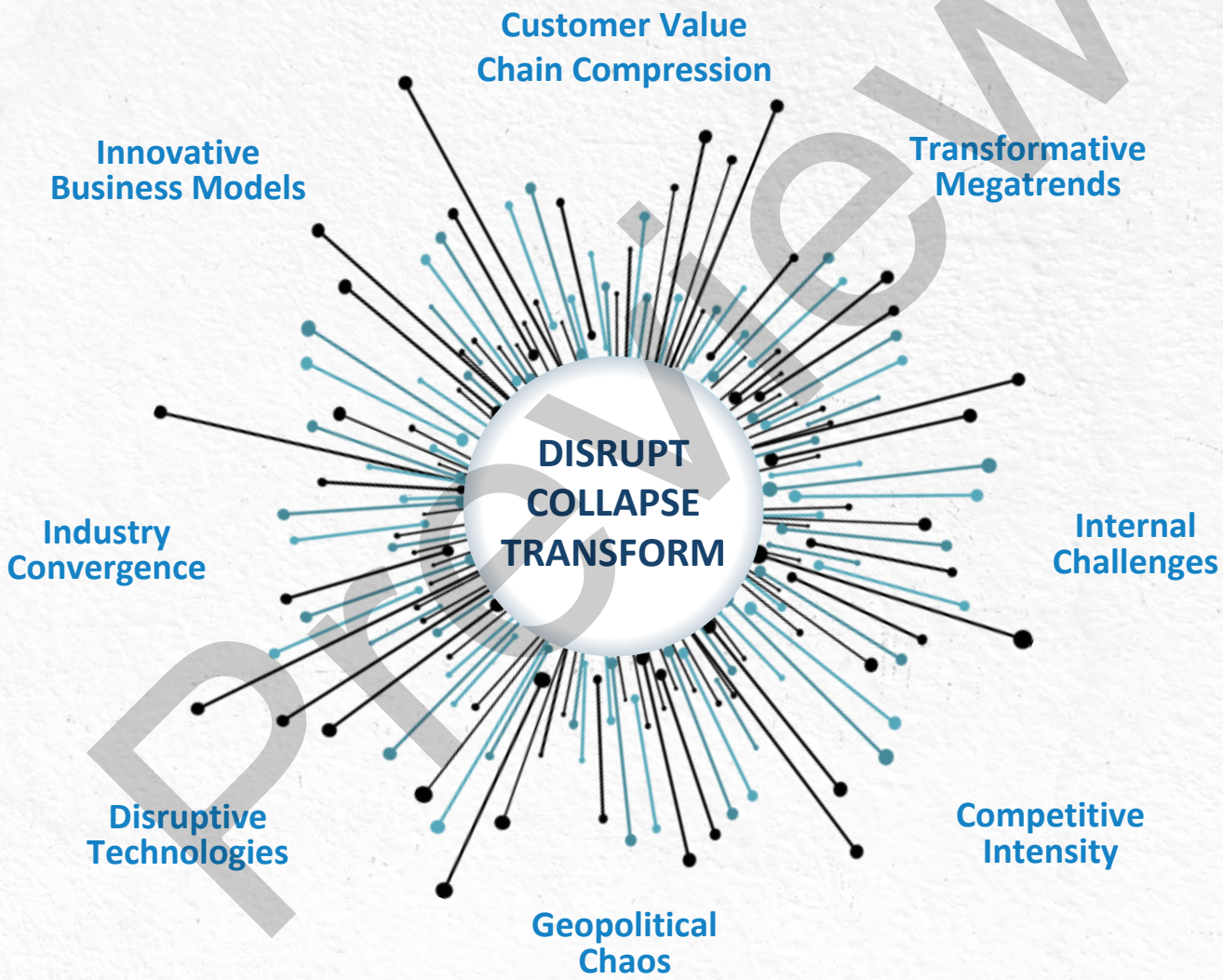
Transformation in the Software-Defined Vehicle Sector

Is your company prepared to Survive and Thrive through the coming Transformation?

Preview

Why Is It Increasingly Difficult to Grow?

The Strategic Imperative 8™: Factors Creating Pressure on Growth



PREVIEW

Source: Frost & Sullivan

The Strategic Imperative 8™

Innovative Business Models	Customer Value Chain Compression	Transformative Megatrends	Internal Challenges
A new revenue model that defines how a company creates and capitalizes economic value, typically impacting its value proposition, product offering, operational strategies, and brand positioning	Customer value chain compression as a result of advanced technologies, internet platforms, and other direct-to-consumer models that enables reduction in friction and the number of steps in customer journeys	Global forces that define the future world with their far-reaching impact on business, societies, economies, cultures, and personal lives	The internal organizational behaviors that prevent a company from making required changes

Competitive Intensity	Geopolitical Chaos	Disruptive Technologies	Industry Convergence
A new wave of competition from start-ups and digital business models that challenge the standing conventions of the past, compelling established industries to re-think their competitive stance	Chaos and disorder arising from political discord, natural calamities, pandemics, and social unrest that impact global trade, collaboration, and business security	New, disruptive technologies that are displacing the old, and significantly altering the way consumers, industries, or businesses operate	Collaboration between previously disparate industries to deliver on whitespace cross-industry growth opportunities

Preview

Source: Frost & Sullivan

The Impact of the Top 3 Strategic Imperatives on the Benchmarking of European OEM Software-defined Vehicle Strategies

SI8	Disruptive Technologies	Internal Challenges	Industry Convergence
WHY	• The increased proliferation of electronically driven features in modern vehicles has raised the complexity of in-vehicle electrical/electronic (E/E) platforms, adding weight and cost to vehicles. • Case convergence is leading to the growing addition of software (SW)-driven features, increasing processing, communication, and power requirements.	• To ensure success in the SW-defined vehicle (SDV) space, organizations must transition from function-oriented to platform development structures. • The shortage of talented engineers with knowledge of HW and SW and automotive engineering is likely to continue.	• The SW-oriented business approach is replacing the HW model and is the only viable means of revenue generation. • Therefore, automakers, suppliers, and technology providers must partner deeper to develop vehicles with SW-oriented architecture.
FROST PERSPECTIVE	• With support from the automotive ecosystem, OEMs are addressing the challenges posed by EE architecture by decoupling hardware (HW) from SW, using high-powered controllers, and redesigning HW architecture. • Working closely with semiconductor and SW companies, OEMs are developing processors, components, systems communication protocol, and SW to effectively manage growing requirements.	• Some OEMs have started the migration, partly by hiring interdisciplinary talent with expertise in cybersecurity, SW stack development, artificial intelligence (AI), and the Internet of Things (IoT). • Automotive companies in the SDV sector must strategize their recruitment and talent management policies to get the best engineers for various domains.	• Recent partnerships in the SDV ecosystem indicate that automakers are willing to expand their partnership status with companies not traditionally associated with the automotive industry. • To successfully emerge from this process, automakers must redefine their organization, infrastructure, and vehicle architecture and consider factors, such as investment, R&D costs, and vehicle costs. Realizing any meaningful revenue will take at least 10 years.

Preview

Source: Frost & Sullivan

FROST & SULLIVAN



Ecosystem

How is the complexity of Ecosystem impacting your Future Growth Potential?

Preview

Research Scope

- The automotive industry is transforming from a hardware (HW) to a software (SW) approach to building vehicles.
- Vehicles are increasingly complex with more lines of SW code than the previous year.
- The concept of software-defined vehicles (SDVs) has gained traction in the industry, impacting product and feature development philosophies.
- This study investigates the strategies of European OEMs in the SDV space and benchmarks them against each other.

Scope	
Geographic coverage	Global
Study period	2023–2030
Base year	2023
Forecast period	2024–2030
Monetary unit	US Dollars

Key Questions this Study will Answers

- What strategies are OEMs adopting to standardize hardware?
- What strategies are OEMs applying to standardize software?
- What are OEM strategies for SDV?
- How are OEMs utilizing their existing ecosystems to achieve SDV?
- Which European OEM Group is leading the SDV race?

Key OEMs Groups included in this Report

BMW	Mercedes-Benz	Renault-Nissan-Mitsubishi Alliance
Stellantis	Volkswagen	Volvo

Source: Frost & Sullivan

Preview

Growth Drivers

SDV Strategies: Growth Drivers, Global, 2023–2030



Driver	1–2 Years	3–4 Years	5–7 Years
Increasing Input Costs and Constant Efficiency Improvement Pressures The need to meet consumer demand, greater regulatory compliance requirements, and increasing technology sophistication have led to an increase in input costs for OEMs, negatively impacting their profit and loss statement. Migrating to SDVs will enable OEMs to better manage costs and drastically improve efficiency.	High	High	Medium
Unlocking New Services Using Data Analytics Data analytics allows OEMs to unravel product/feature usage insights, which can be useful for optimizing functions and SW. Additionally, predictive and personalized services, such as maintenance, insurance, and vehicle app-stores, could be new avenues to generate revenue.	High	Medium	Medium
HW and SW Decoupling Decoupling SW and HW enables the standardization of toolchains, making OEM development processes consistent across internal teams and external stakeholders. Additionally, it helps OEMs implement OTA to realize new business models over the vehicle life cycle.	Medium	Medium	Medium

Preview

Source: Frost & Sullivan

Growth Restrains

SDV Strategies: Growth Restraints, Global, 2023–2030



Restraint	1–2 Years	3–4 Years	5–7 Years
SDVs Need Advanced HW and SW The existing E/E architecture cannot meet increasing demands for computing power and increased communication efficiency and bandwidth. Vehicle E/E architecture must shift from a distributed to a centralized model to become compact and scalable.	High	High	High
Limitations of the Traditional SW Development Model Traditional automotive SW R&D employs a waterfall development model that caters to a linear R&D ecosystem in which product R&D ends when production starts. This process will need to transition to agile development to allow constant iteration to address changing market needs and reduce time to market.	High	High	Medium
Organization Structure and Limited Talent Supply To succeed in SDVs, organizations must transition from a function-oriented to a platform-development structure. Additionally, talented engineers with knowledge of HW, automotive engineering, and automotive SW are in short supply.	High	Medium	Medium

Preview

Source: Frost & Sullivan

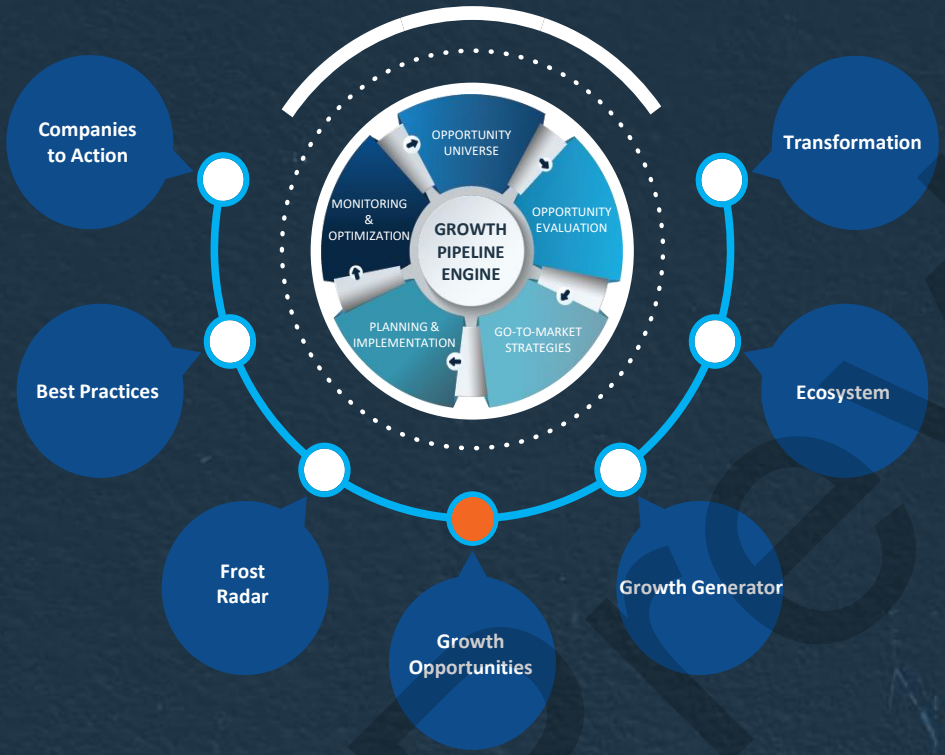
Segmentation

Definitions	
Distributed Architecture	A distributed E/E architecture is where one ECU represents one vehicle application.
Integrated Architecture	This is a variation of the distributed architecture where one or more vehicle functions are integrated into one ECU (e.g., a body control module that hosts a plethora of body functions in one ECU).
Hybrid/Partial Domain Controller Architecture	A hybrid domain controller architecture is an E/E architecture where one or more domains are carved out from the existing integrated architecture. In such an architecture the domain controller controls all control strategies of that particular domain (e.g., cockpit domain controller).
Full Domain Controller Architecture	In a full domain controller architecture, functional consolidation occurs in 4 to 7 domain controllers, such as powertrain, connectivity, ADAS and AD, body and comfort, infotainment, and in-vehicle experience. The domain controllers (DCs) manage the strategy of sensors and actuators and are physically isolated, communicating with each other through service-oriented gateways.
Hybrid/Partial Domain-Zonal Architecture	An E/E architecture in which one or more zones have been carved out from the full domain controller architecture based on geographic proximity and not on function. The remaining architecture represents domain controller architecture.
Zonal Architecture	In zonal architecture, modules are clustered based on geographic proximity and not on function. Zonal module interfaces between small microcontrollers and the central compute system, translating the language to be transmitted through Ethernet.

Preview

Source: Frost & Sullivan

FROST & SULLIVAN



Growth Opportunity Universe

What Growth Strategies have you embraced to maximize your Growth Potential?

Preview

Growth Opportunity 1: Evolving Ecosystem

Opp. Size in 5 Years	Over USD 1 B
Timeline for Action	Over 3 to 5 Years
GO Base Year	2024

Relevant End-User Industries for this Growth Opportunity

- Manufacturing
- Mobility
- Metal & Mining
- Energy & Environment
- Chemicals & Materials
- Information & Communications Technologies
- Electronics & Semiconductors
- Agriculture, Food & Nutrition
- Govt and Public Sector
- Construction
- Education
- Healthcare & Lifesciences
- Consumer
- Aerospace
- Hospitality
- Retail
- Defense
- Banking & Financial Services

Applicable Regions

- Central & East Europe
- South Asia
- Western Europe
- CIS
- North America
- Latin America
- Africa
- Middle East
- Asia-Pacific

Frost & Sullivan has identified 10 Growth Processes that serve as levers for determining and evaluating new Growth Opportunities.

Growth Processes

- Customer & Branding
- Distribution Channel
- Geographic Expansion
- Vertical Market Expansion
- Competitive Strategy
- Strategic Partnering
- Product Development
- Mergers & Acquisitions
- Product Launch
- Technology & IP

Preview

Source: Frost & Sullivan

Growth Opportunity 2: FoD Business Model

Opp. Size in 5 Years	Over USD 1 B
Timeline for Action	Over 3 to 5 Years
GO Base Year	2024

Relevant End-User Industries for this Growth Opportunity

- Manufacturing
- Mobility
- Metal & Mining
- Energy & Environment
- Chemicals & Materials
- Information & Communications Technologies
- Electronics & Semiconductors
- Agriculture, Food & Nutrition
- Govt and Public Sector
- Construction
- Education
- Healthcare & Lifesciences
- Consumer
- Aerospace
- Hospitality
- Retail
- Defense
- Banking & Financial Services

Applicable Regions

- Central & East Europe
- South Asia
- Western Europe
- CIS
- North America
- Latin America
- Africa
- Middle East
- Asia-Pacific

Frost & Sullivan has identified 10 Growth Processes that serve as levers for determining and evaluating new Growth Opportunities.

Growth Processes

- Customer & Branding
- Distribution Channel
- Geographic Expansion
- Vertical Market Expansion
- Competitive Strategy
- Strategic Partnering
- Product Development
- Mergers & Acquisitions
- Product Launch
- Technology & IP

Preview

Source: Frost & Sullivan

Growth Opportunity 3: Pan-industry Collaboration

Opp. Size in 5 Years	Over USD 1 B
Timeline for Action	Over 3 to 5 Years
GO Base Year	2024

Relevant End-User Industries for this Growth Opportunity

- Manufacturing
- Mobility
- Metal & Mining
- Energy & Environment
- Chemicals & Materials
- Information & Communications Technologies
- Electronics & Semiconductors
- Agriculture, Food & Nutrition
- Govt and Public Sector
- Construction
- Education
- Healthcare & Lifesciences
- Consumer
- Aerospace
- Hospitality
- Retail
- Defense
- Banking & Financial Services

Applicable Regions

- Central & East Europe
- South Asia
- Western Europe
- CIS
- North America
- Latin America
- Africa
- Middle East
- Asia-Pacific

Frost & Sullivan has identified 10 Growth Processes that serve as levers for determining and evaluating new Growth Opportunities.

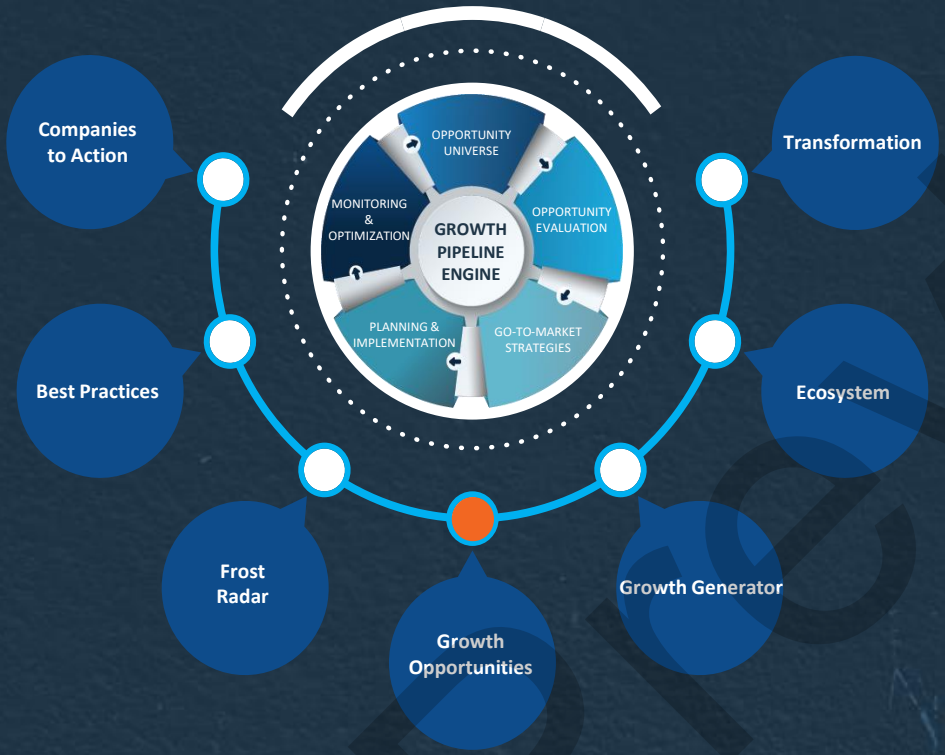
Growth Processes

- Customer & Branding
- Distribution Channel
- Geographic Expansion
- Vertical Market Expansion
- Competitive Strategy
- Strategic Partnering
- Product Development
- Mergers & Acquisitions
- Product Launch
- Technology & IP

Preview

Source: Frost & Sullivan

FROST & SULLIVAN



Next Steps

How does your organization identify & prioritize Growth Opportunities?

Preview

Benefits and Impacts of Growth Opportunities



1

Survive & Thrive:

The Coming Transformation

2

Maximize:

Future Growth Potential

3

One Team:

CEO's Growth Team is inspired & unified

4

Implementation:

Align with Growth Opportunities

5

Brand Power:

Investor-Customer-Employee

Which of these benefits would be most important to your Investor-Customer-Employee?

Source: Frost & Sullivan

Legal Disclaimer

Frost & Sullivan is not responsible for any incorrect information supplied by companies or users. Quantitative market information is based primarily on interviews and therefore is subject to fluctuation. Frost & Sullivan research services are limited publications containing valuable market information provided to a select group of customers. Customers acknowledge, when ordering or downloading, that Frost & Sullivan research services are for internal use and not for general publication or disclosure to third parties. No part of this research service may be given, lent, resold, or disclosed to noncustomers without written permission. Furthermore, no part may be reproduced, stored in a retrieval system, or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise—without the permission of the publisher.

For information regarding permission, write to: permission@frost.com

Preview

© 2024 Frost & Sullivan. All rights reserved. This document contains highly confidential information and is the sole property of Frost & Sullivan.
No part of it may be circulated, quoted, copied, or otherwise reproduced without the written approval of Frost & Sullivan.

Want To Accelerate Growth? We Can Help!

Frost & Sullivan understands how to prepare companies in the face of an uncertain future. Our global team of consultants work with clients worldwide to help them navigate the many complexities facing their industries and allow them to take advantage of current growth opportunities while positioning them for even more significant growth in the future.

Technology Expertise
Expertise in all enabling technologies for digital transformation, including IoT, cloud computing, big data analytics, security, mobility and value-added services

Industry Convergence
In-depth understanding of digitization Opportunities across the ecosystem, including business models and industry transformation

In-depth Coverage
Expertise and market knowledge to help clients achieve growth objectives by adapting to the new digital economy

Global Perspective
Global expertise across technology applications and verticals, including manufacturing, automotive, healthcare, and many more

Unparalleled Support
Approximately 1,200 analysts and consultants tracking applications, verticals and enabling technologies for digital transformation

Schedule a complimentary dialogue with our team to discuss your strategic growth development

1.877.463.7678 | www.frost.com | myfrost@frost.com | Online Purchase

SILICON VALLEY
3211 Scott Blvd
Santa Clara, CA 95054
Tel 650.475.4500
Fax 650.475.1571

SAN ANTONIO
7550 West Interstate 10
Suite 400
San Antonio, TX 78229
Tel 210.348.1000
Fax 210.348.1003

LONDON
Floor 3 - Building 5,
Chiswick Business Park,
566 Chiswick High Road,
London W4 5YF
Tel +44 (0)20 8996 8500
Fax +44 (0)20 8994 1389

