FTF FREESCALE TECHNOLOGY FORUM 2015

Component Selection

The Make-or-Break Milestone Towards Autonomous Vehicles

FTF-ACC-F1266

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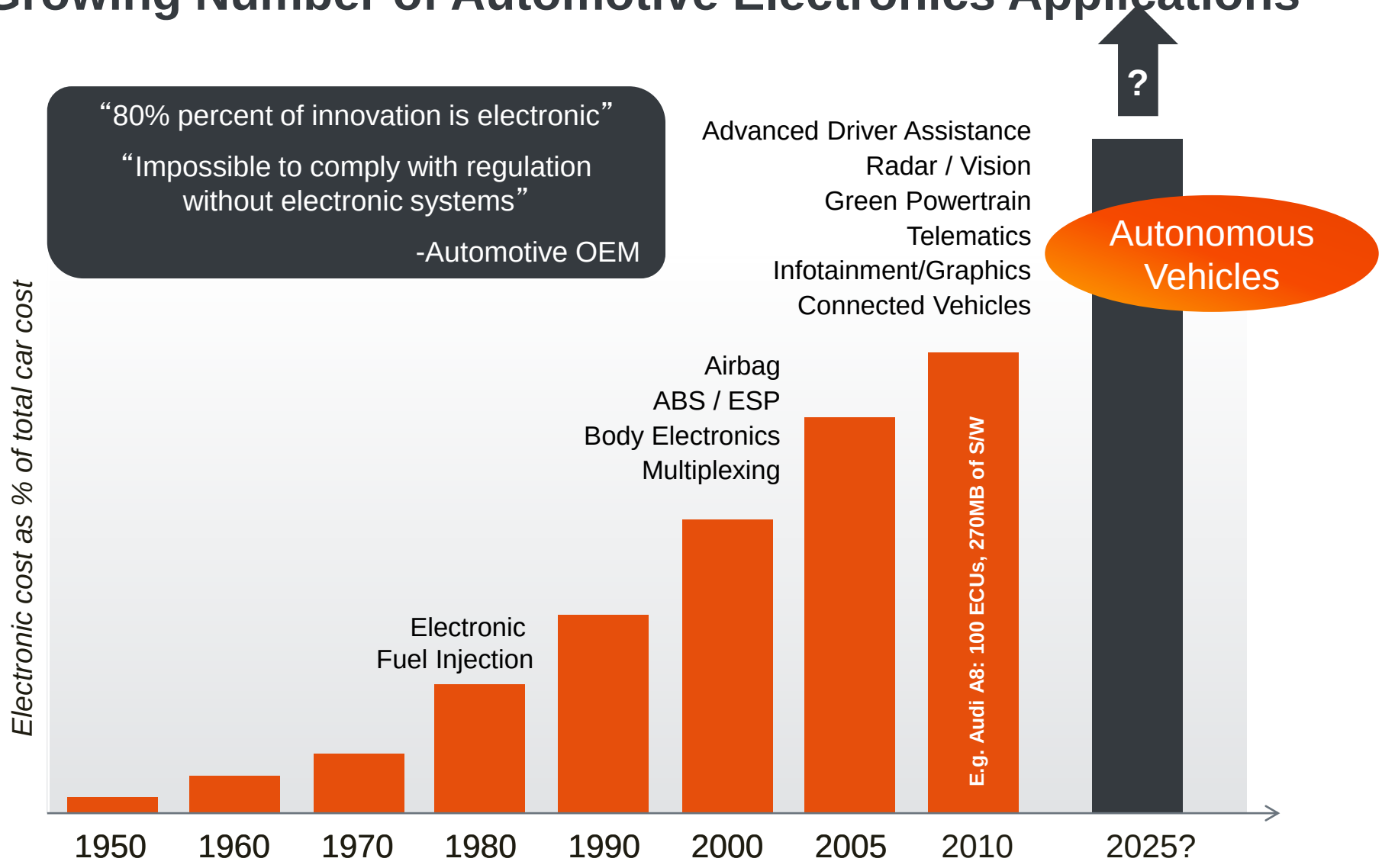
Agenda

- The Evolution of the Automotive Electronics Market
- Industry Risk — Consumer Components in Safe Automotive Applications – ZVEI* Work Group
- Truly different: Automotive Semiconductors and Consumer Components! – Fact Sheet
- Freescale Value Creation Towards Autonomous Driving — Examples
- “Autonomous Driving Crossroad”

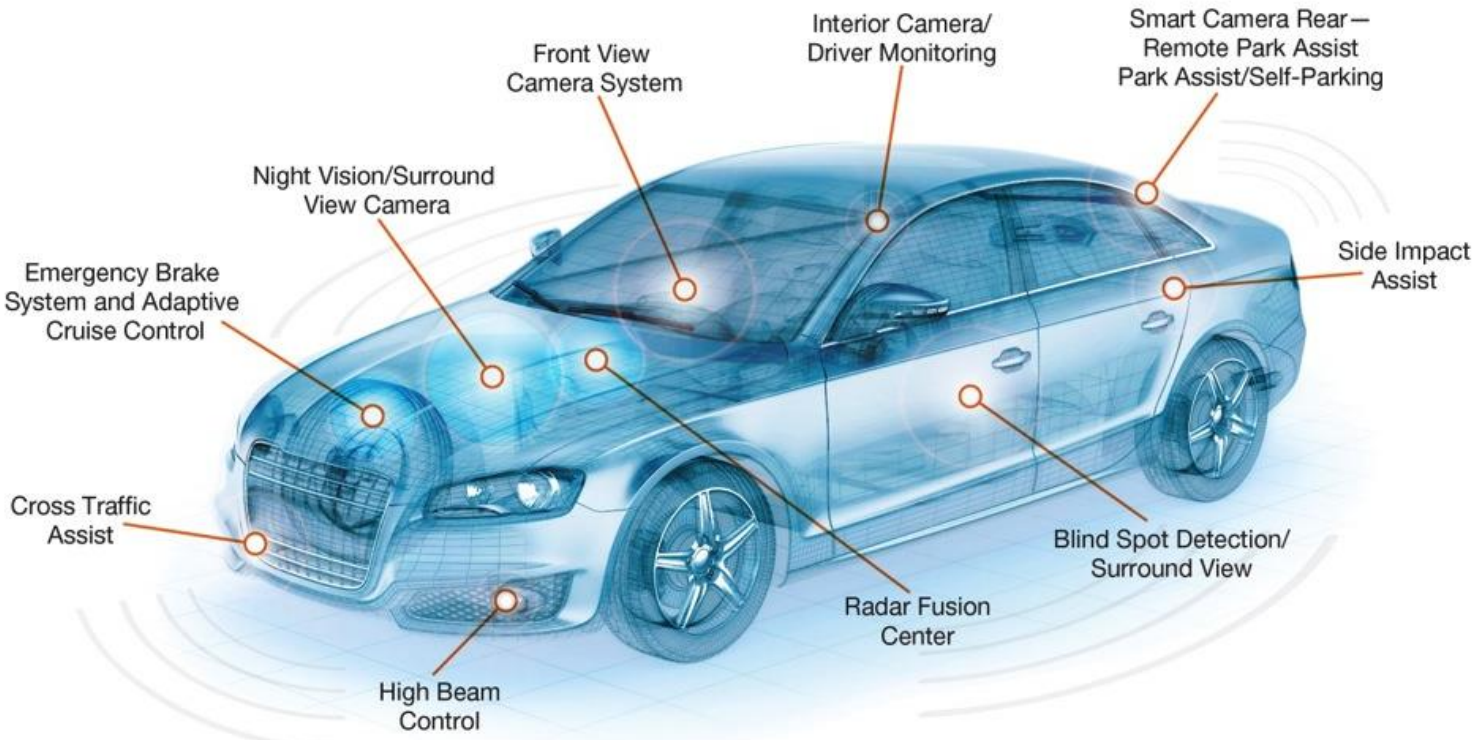
*ZVEI: German Industry Association of Electric and Electronic Industry

Growing Number of Automotive Electronics Applications



Automotive Moving Towards Leading Edge Technology

Advanced Driver Assistance System Applications



- The next generation of automated driving requires leading edge compute intelligence to exchange and evaluate all the data
- This level of compute power may not reside in a controller specifically designed for automotive

Exploding R&D Costs in the Semiconductor Industry

(extract Baden-Baden 2012)

- R&D increases caused by
  - Growing technology complexity
  - Growing product complexity
  - Growing materials cost: wafers and masks
  - Enablement, software, solutions creation

R&D spending as % of sales in the semiconductor industry	
Late 70's, early 80's	7 to 8%
Early 90's	10 to 12%
2000–2010	~ 15%
2008 record	17.5%
2011	15.5%
2012 Forecast	16.2% ($53.4B)

Source: McKinsey 2011

McKinsey Oct. 2013:

"Complex integrated chip designs now exceed $100M, with designs of $20M – $30M becoming commonplace among more standard or basic components. Consider a $100M development investment. It's business case typically demands at least a $500M return."

How Many New 32-bit MCU Products Can Automotive Justify in the Future? (Baden-Baden 2012)

$$\text{Nbr of NPI} = \frac{\text{Market Size x (\% corp. R\&D x \% product R\&D)}}{\text{R\&D\$ per NPI}} \times \text{Technology Cycle Time}$$

Source: VLSI Research Dan Hutcheson (modified)

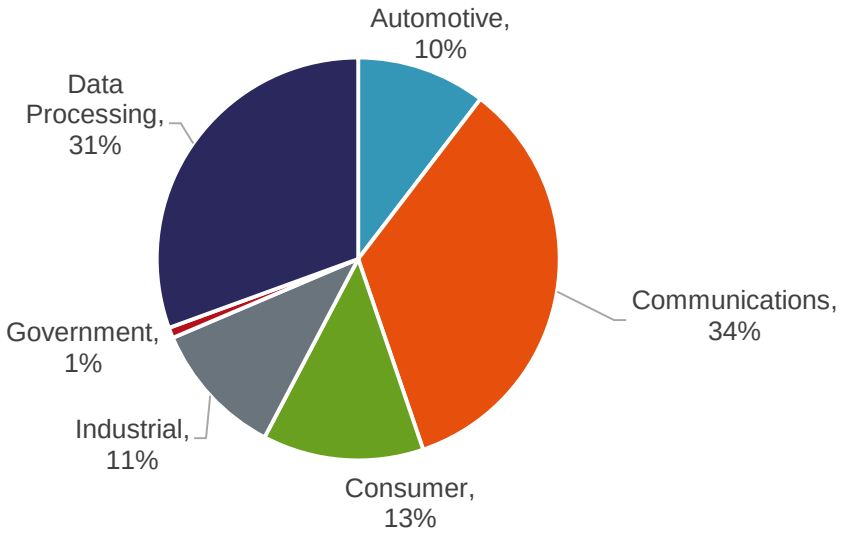
32-bit Auto MCU example	values	Notes
Market size 32-bit Auto MCU	$3 336 M	Units x ASP 2011 data from Strategy Analytics
Avg. corporate R&D	15%	2011: 15.5% industry average
Avg. Product R&D *	50%	Amount of corporate R&D$ dedicated to product development
Avg. R&D$ per NPI **	$10.0 M	Exploding R&D costs (cost point for 55 nm; >50% increase per technology node)
Technology cycle time	3 years	New technology node every 3 years
Max number of NPI the industry can afford in one technology cycle	75	in 55 nm
	50	in 40 nm
	33	in 28 nm

for the total auto industry !
across all applications,
across all suppliers

* Source VLSI research
** Source: Freescale estimate

The Future of Components Used in Automotive

- Automotive represents only 10% of the global semiconductor market*
- The variety of products requested continues to rise
  - Growing number of applications
- R&D investment required for leading-edge components is exploding
  - Automotive requirements add substantial costs
- The number of products that the automotive market can justify will reduce substantially
  - Specifically affecting the high-performance space
- The automotive players need to find ways to also integrate “standard components”** into vehicles while meeting quality, reliability, lifetime and safety targets

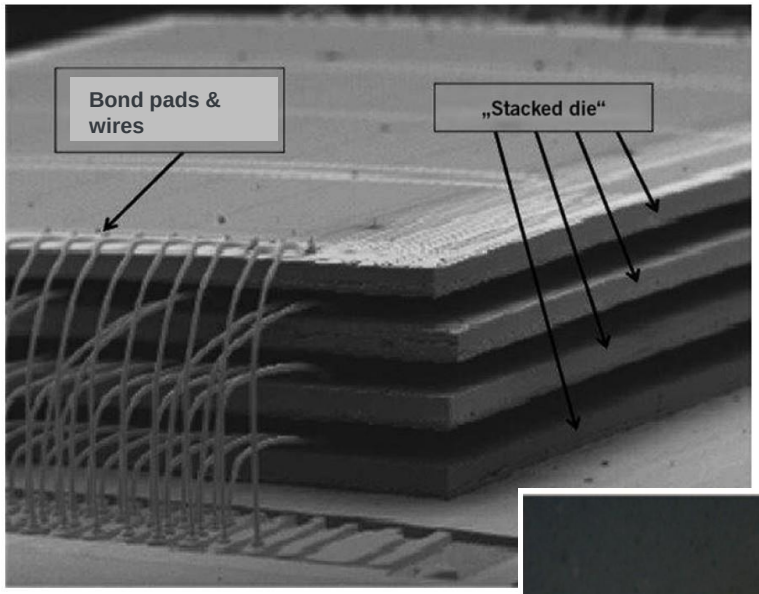


* Source: WSTS 2014

** Any components not specifically developed for target market automotive

Industry Risk — Consumer Components in Safe Automotive Applications – ZVEI Work Group

Problem Statement - Example



- Memory stacked-die BGA module construction designed for consumer use case
- Fit for use in mobile phones, but bond wire cracks will create reliability issues in Automotive use case
- Differences in mission profile e.g. vibration, temperature cycles
  - Various Auto mission profiles possible in the vehicle
- This is not „poor quality“
  - Systemic designed-in capability
  - Successful design for target mission profile
  - Product reliability frozen after product design
  - No compensation by „try harder“ in production

Sources:
1.) Springer 2010 ISBN 978-1-4419-6347-5 e-ISBN 978-1-4419-6348-2
2.) IFAS GmbH, Dortmund, Germany

Consumer Components in Safe Automotive Applications

The targets of the new ZVEI* work group (founded Jan ‘14)

ZVEI: Die Elektroindustrie

1. Create awareness: all potential differences — automotive vs. consumer components

2. Define a collaboration process with car OEM / Tier1 on vehicle / ECU development to:
   - Identify potential risks
   - Conscious decisions on how to resolve or mitigate applicable risks
     - Closed-loop communication
     - Resulting in robust system level solutions
   - Align change management & product life cycle/availability expectations with typical standard component cycles
   - Accept/refuse the consequences of remaining shortcomings incl. risks for incidents and field failures

*ZVEI: German Industry Association of Electric and Electronic Industry

Consumer Components in Safe Automotive Applications

What Happened So Far, Who is Engaged?

- Participating companies: (add. members joined since Oct ´14*)

*Atmel, Fairchild, Harman, Leopold Kostal, Murata, Osram,Taiyo Yuden, Texas Instruments, Vishay, as well as Mr. Keller and Mr. Gresch

- First brainstorming Dec 2013 in Munich
- Work group kick-off January ´14
- Work group leader: Stephan Lehmann / Freescale
  - July ´14: Final release of position paper
  - Sept ´14 — involve Tier1 members of ZVEI
    - Bosch, Hella, Marquardt, Brose, TRW, Kostal, Webasto, Harman, Siemens
  - Work Group support expanding since Q4/14:
    - Atmel, Fairchild, Harman, Kostal, Murata, TI, Osram, (Intel)
  - Feb 11th: Fact Sheet release “Pot. differences between automotive targeted components and consumer components”
  - Next step: approaching CarOEMs
  - **While this initiative started in Europe, it is relevant to all of us globally and Freescale invites you to connect!**

Position Paper Available — English and German

Topical summary in brief:

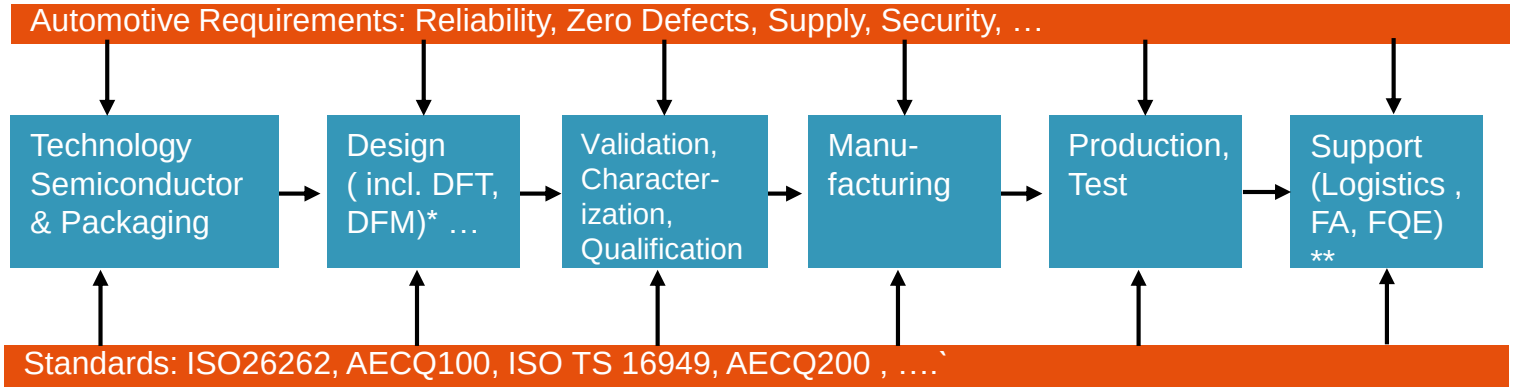
- Increasing demand to use consumer grade semiconductors in vehicles
- Truly different: automotive semiconductors and consumer parts
- Resulting new and growing industry risks often unknown
- Automated driving vision requires new level of industry-wide cooperation
- Experienced automotive suppliers in ZVEI reach out to OEMs

Downloads via ZVEI-Homepage:

http://www.zvei.org/Verband/Fachverbaende/Automotive/Seiten/Consumer-Components-in-Safe-Automotive-Applications.aspx

Truly Different: Automotive Semiconductors and Consumer Components! – Fact Sheet

Truly Different: Automotive Semiconductors and Consumer Components



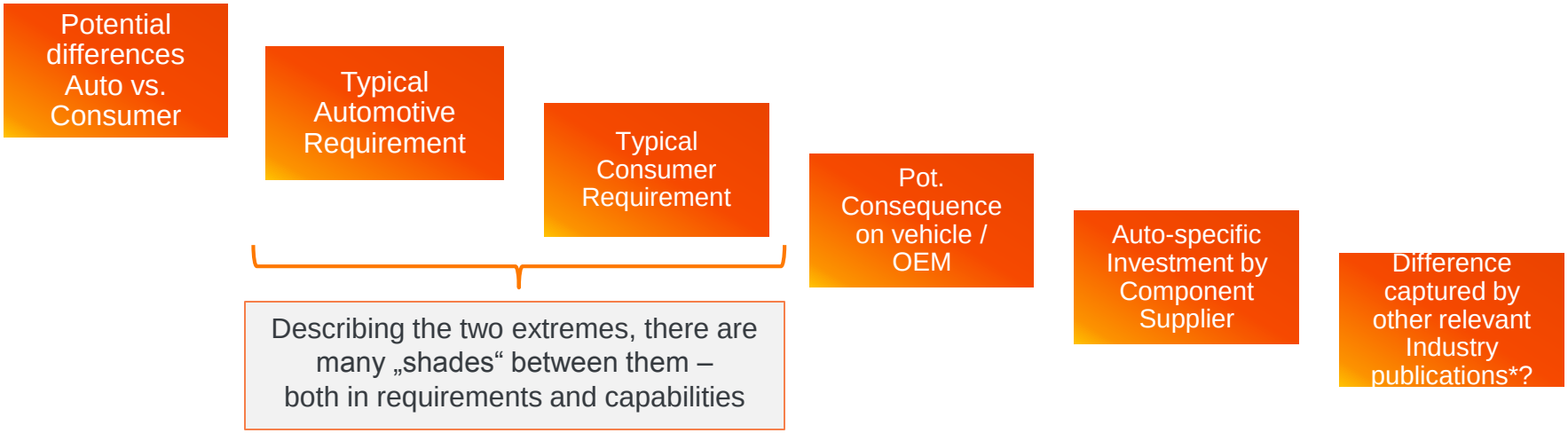
- 6 categories for potential differences:
  - Technology Development — Semiconductor
  - Technology Development — Packaging
  - Component Development — Product Design
  - Component Validation, Characterization, Qualification
  - Component Manufacturing, Production, Test
  - Component Supplier — Applicable Standards and Processes / Added value support

Component capability is frozen latest at the end of product design

- 66 possible differences have already been identified by the ZVEI work group. Components and suppliers satisfy criteria to varying degree.

* DFT: Design for Test, DFM: Design for Manufacturability
** FA: Failure analysis, FQE: Field Quality Engineering

Fact Sheet Content



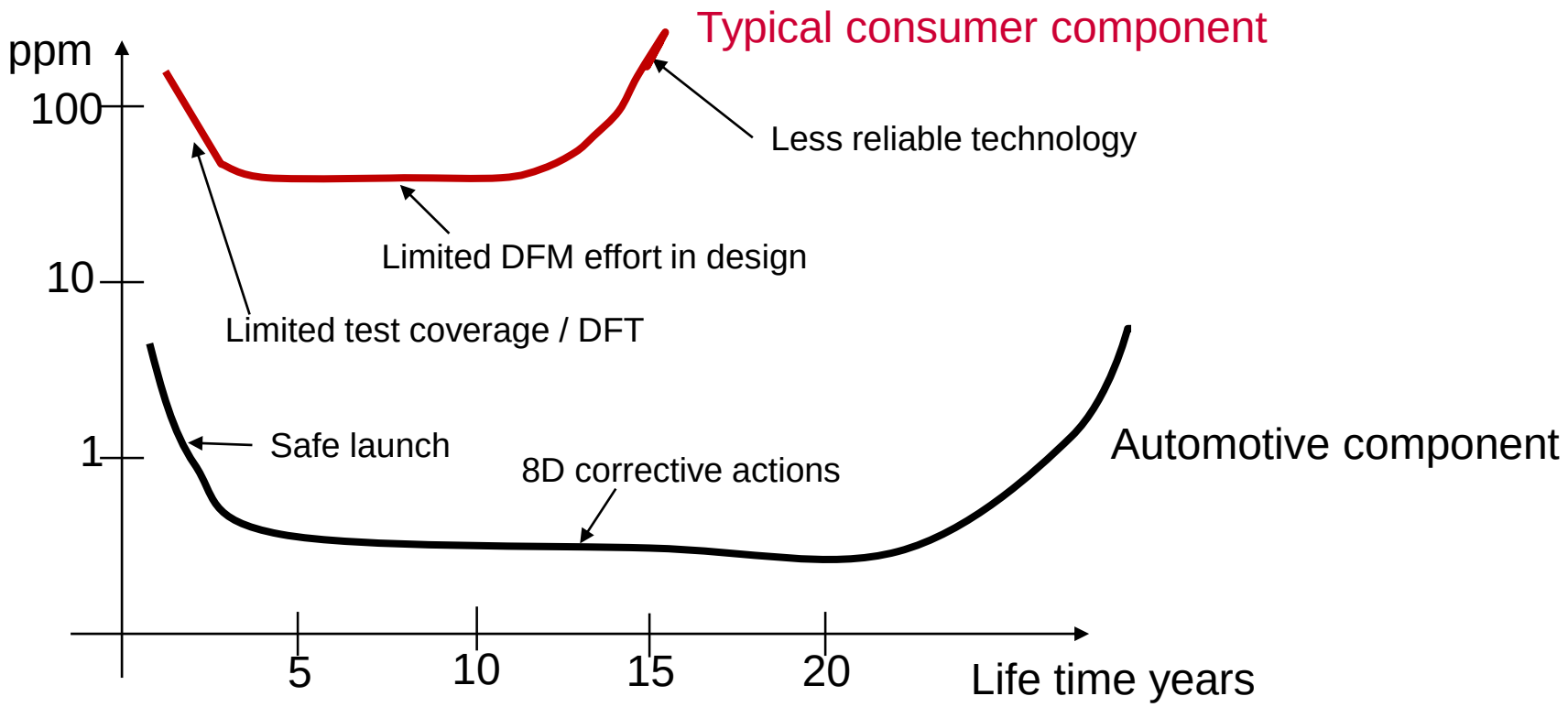
- Fact Sheet finalized in February 2015
- Most comprehensive list of potential differences in the industry
- * Other identified relevant Industry publications:
  - VDA* - OEM consumer component risk assessment guideline
  - BMW Group Standard (rev 2013, new revision in preparation in collaboration with 2nd OEM)
  - VW Semiconductor Group Standard released Feb. 2015, English version in preparation
    (not assessed yet in fact sheet)

VDA: Association of German Automotive OEM (members incl. OEM and Tier1)

66 Potential Differences — Automotive vs. Consumer

Tempera-ture Range	Metal line Electro-migration caused by current density	TDDB (Time dep. Dielectric break down) — Metalli-zation	TDDB — Transistor Gate oxide Lifetime	Transistor Aging margin for Auto life-time degra-dation	Radiation Susceptibil ity (SER/ SEL)	NVM Data Retention	NVM write/ erase	NVM Program-ming	Techno-logy Certifi-cation	Reliability Require-ments
Interaction Chip/ Package	Wire bond integrity (Gold, Cu, etc)	Alternative Package connection technology	Mold compound	BOM flexibility	Design Rules	Package types	Board level reliability	Product definition	Requireme nts manage-ment	R&D partner-ship
R&D project manage-ment	Robust Design	DFMEA	Design-for-test (DFT)	ECC	Design-for-manufac-turability (DFM)	Design-for-(Failure)-Analysis (DFA)	Std Cell libraries	Power consump-tion	Latchup	Functional Safety Functions
APQP support	Qualifi-cation acc. to AECQ100	Drift Analysis	Charac-terization	PPAP	Test insertions & test coverage	Memory ECC testing	Zero defect test screen strategy	High voltage stress and/or burn-in	PFMEA	Process Controls
Manufactur ing margin / Cpk	Sub-Supplier & Subcontra ctor	Supply security	Quality Manageme nt system / cert. acc. TS16949	VDA audit support (VDA 6.3)	product maturity	FA & 8D support	Commit-ment to confirmed ppm target	Trace-ability	Record retention	MAT Label
PCN handling	product life-cycle manage-ment	EOL handling & stock	FMEA	Supply Agree-ments & CSR	Automo-tive system design support	EMC -ECU design support & component certification	ISO26262 related support	Automotive Software Developm ent	pro-active quality alert process	Material com-pliance & declara-tion

The “Bath Tub Curve” — Quality & Reliability in a Typical Automotive 125°C Mission Profile



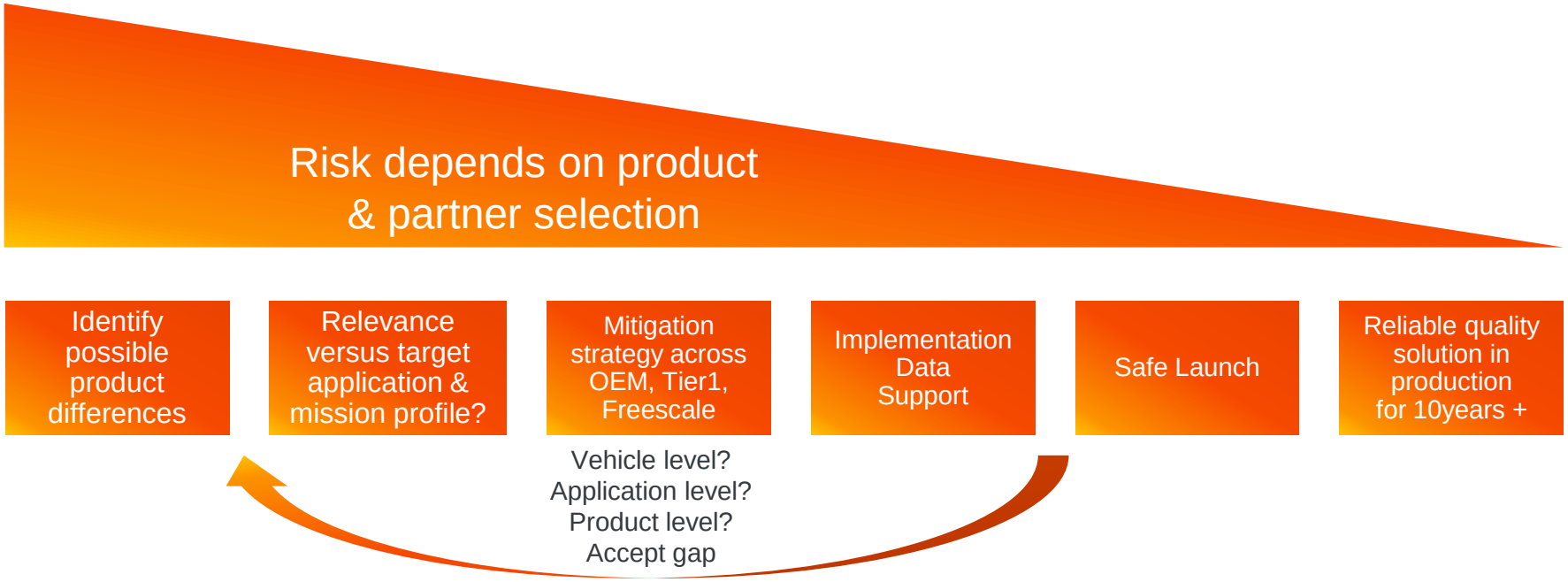
- Right slope is frozen after technology, packaging & product development & can only be influenced by temperature profile

DFT – Design for Test DFM — Design for manufacturability

Consequences of the Differences on Automotive Use

- Component selection risks do not only impact companies, but might lead to direct, personal consequences for the responsible employee or manager
- Zero defect quality & 15 year+ reliability at ECU level in many cases cannot be accomplished with standard components ALONE
- Shortcomings can be mitigated by collaboration between Car OEMs, Tier1 and component suppliers
  - Modified vehicle and/or ECU mission profile
  - System level solutions e.g.
    - Redundancy
    - External component protection
    - Cooling
- Remaining risks need to be understood and accepted by all participants

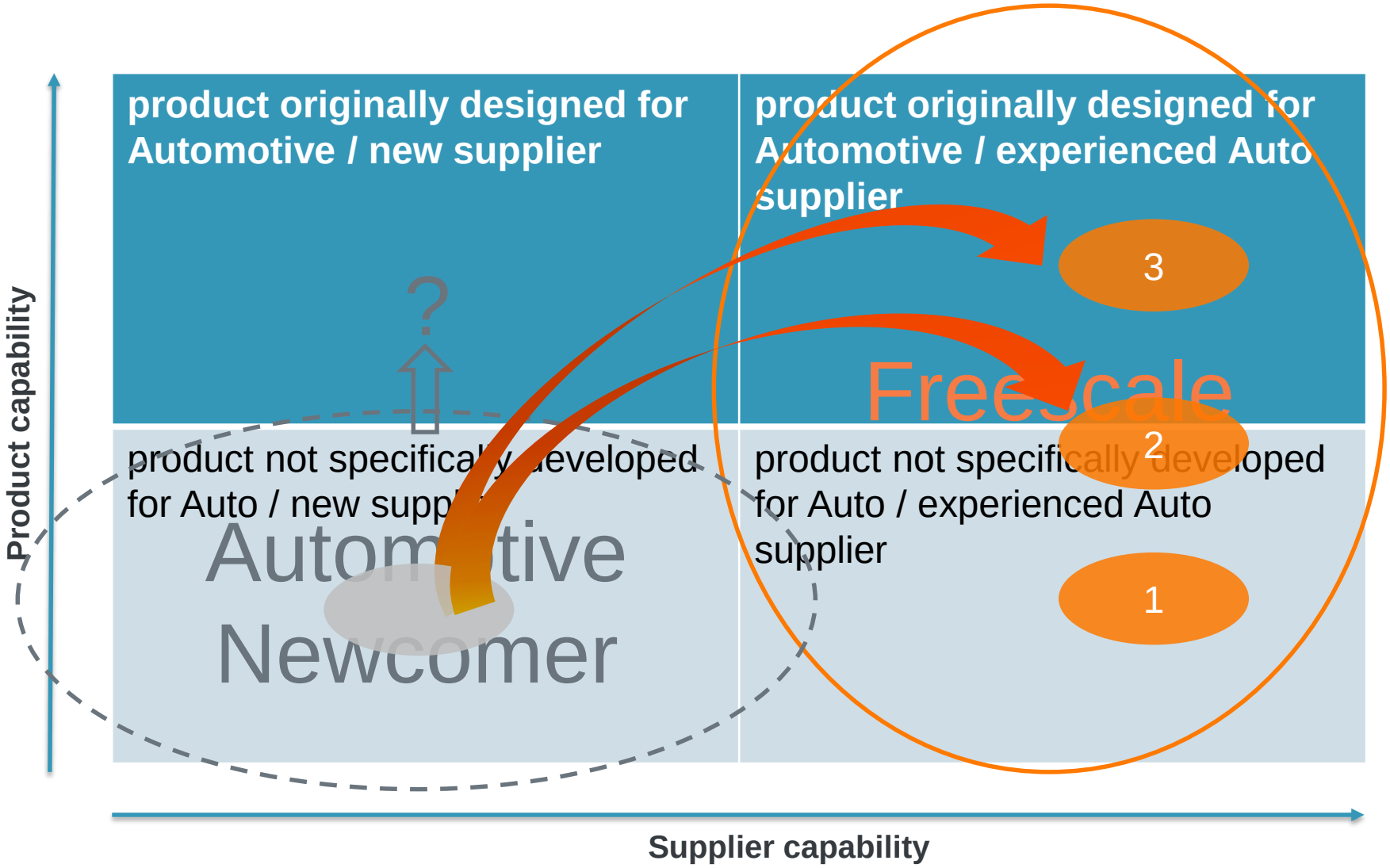
Development Partnership



- The component selection defines how long and risky the application development will be
  - **Product:** size of gap at sourcing decision
  - **Partner capabilities**: potential risk reduction slope
  - **Collaboration**: realized risk reduction
  - **Consequence**: final remaining risks

Freescale Value Creation Towards Autonomous Driving — Examples

ZVEI Fact Sheet “Consumer Components in Safe Auto Applications” — What it Boils Down To



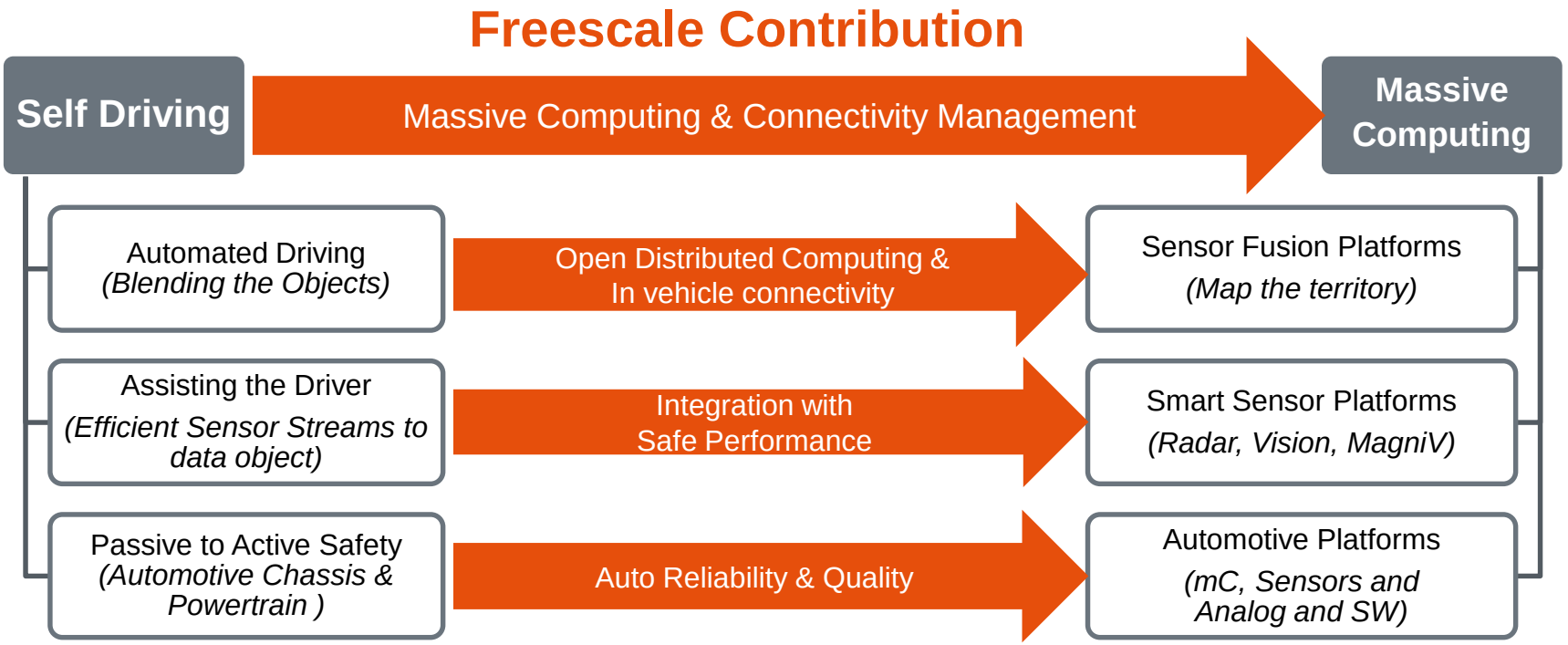
Product & Application Examples

- Freescale offering highly differentiated products and/or services based on conscious decision process & understanding of implications

Application	Product	*Freescale Strategy*	*Freescale offering*	Unique differentiation
Wireless Charging	DSC (MCU + DSP integration)	*1 — non-Auto with Freescale value*	*MWCT100xA*	Lowest application EMC & optimized Software
Autonomous Driving	High performance processor QorIQ	*1 — non-Auto with Freescale value*	*(Layerscape) LS2085A T4240*	Highest reliability even in most auto mission profiles, 10–15 years guaranteed longevity
Graphics / Cluster / Infotainment	Graphics processor	*2 — non-Auto with partial Auto Design & Freescale value*	*i.MX 6 families*	Industry benchmark ppm due to DFM / DFT design flow
HV battery management	integrated 14-cell lithium-ion battery cell controller	*3 — Full Automotive Design instead of non-Auto source*	*MC33771, MC33664*	State-of-the-art: ASIL C safety concept, ISO26262 design flow, full Automotive reliability, Auto driven functionality & higher integration
Vision ADAS*	Safe Vision processor	*3 — Full Automotive Design instead of non-Auto source*	*S32V200 family*	State-of-the-art: ASIL B/C safety concept, ISO26262 design flow, design for reliability and zero defect

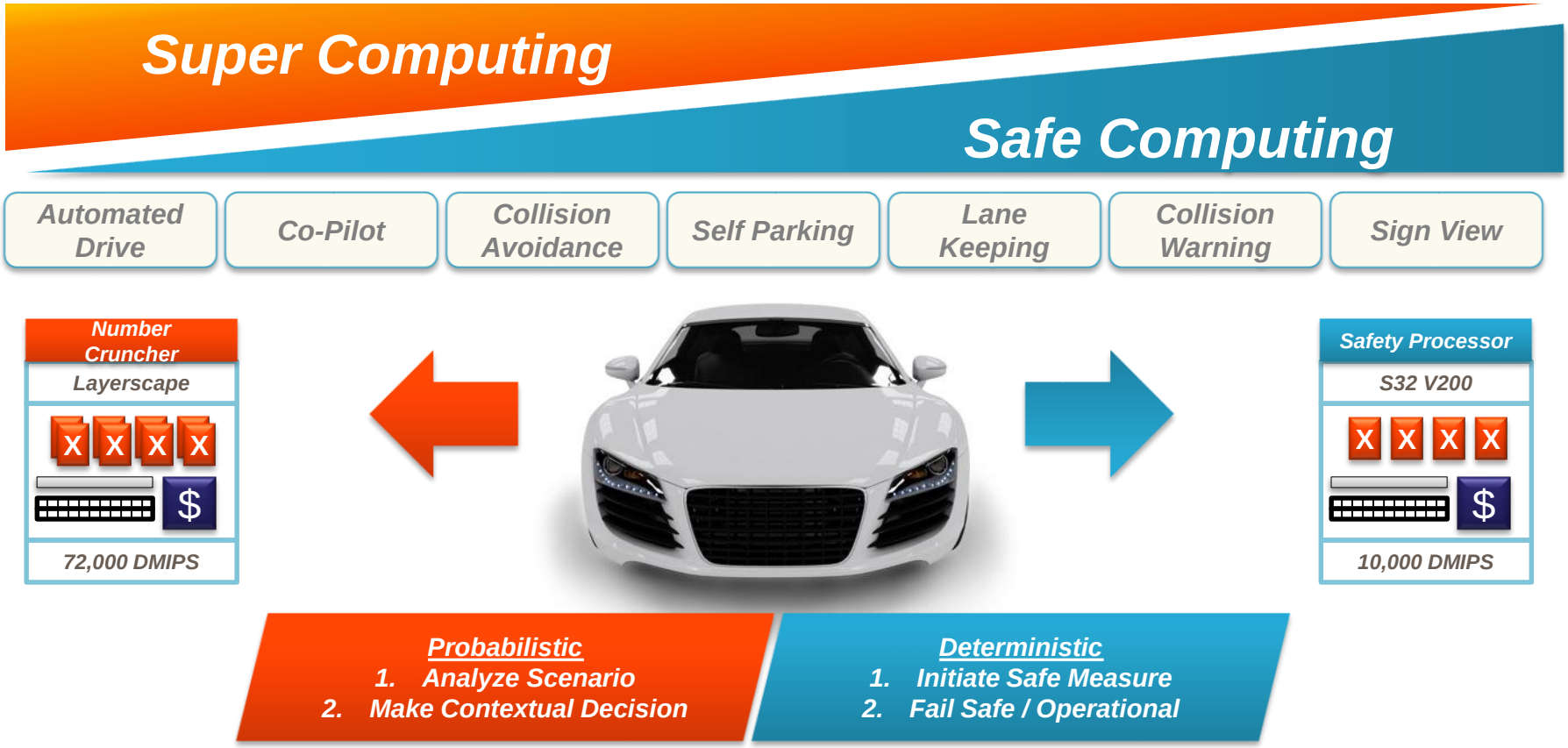
* ADAS: Advanced Driver Assistance System

Progress Toward Autonomous Vehicle

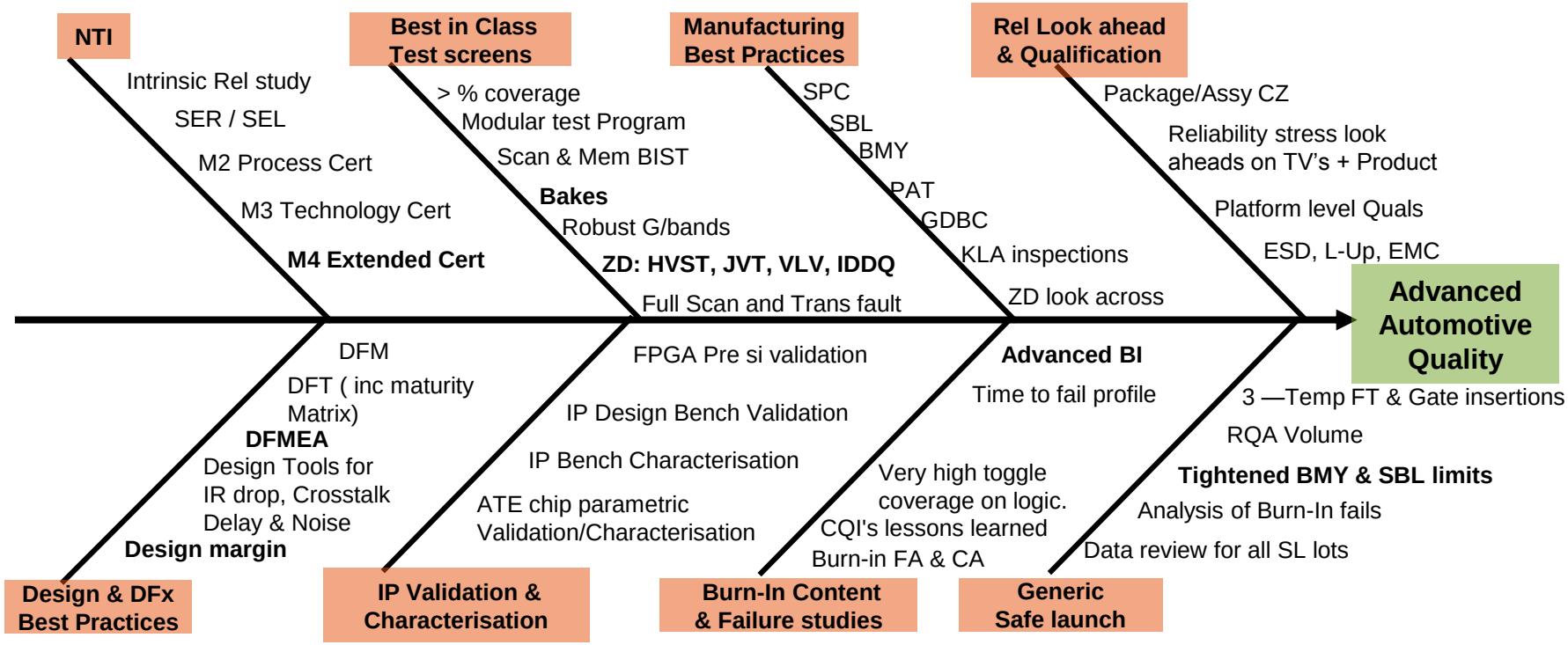


Automotive competence combined with reliable, safe and secure, SW enabled, massive performance

Computing Challenges — FSL Solution



Freescale Advanced Product Quality — Example S32V200



- AECQ100 qualification only tells how bad — not how good — a part is
- Freescale quality & reliability grown in 40 years of Automotive commitment
- Many of those capabilities fan-out to full Freescale product portfolio

Addressing the Challenges of Functional Safety
Freescale SafeAssure Program

- Designing safety-critical systems while meeting state-of-the-art functional safety requirements can be challenging
- **Freescale is a leading supplier of safety solutions**
  - More than 15 years of experience of designing products for safety related applications
  - Shipped more than 70 million MCUs and 60 million Analog products into safety systems such as electronic stability control and anti-lock braking
- Our **SafeAssure** program helps automotive and industrial OEMs **achieve end system compliance with functional safety standards**
- Certification of the SafeAssure hardware development process for analog and sensors as suitable for development of ISO 26262 compliant hardware product components underscores **our commitment to simplifying the process of achieving system compliance.**

SafeAssure Approach: The Four Key Elements

Documentation SAFE ASSURE™ by Freescale Attach Strategy Enablement

AN4442 — MPC5643L and MC33907/08 for Safety Applications


Integrating the MPC5643L and MC33907/08 for Safety Applications

by: Gene Fortenaty and Barbara Johnson

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1 Introduction

2 MPC5643L Overview

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AN4766 — MC33907/08 A.N. & PCB guidelines


MC33907_08 System Basis Chip

1 Introduction

2 Overview

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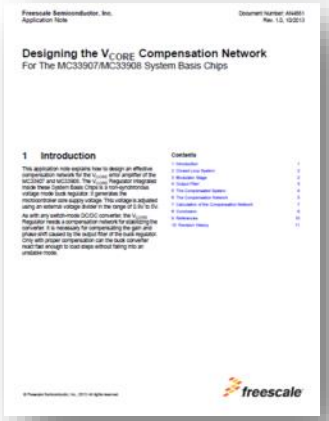
Designing the Vcore Compensation Network


Designing the V_{CORE} Compensation Network

For The MC33907/MC33908 System Basis Chips

1 Introduction

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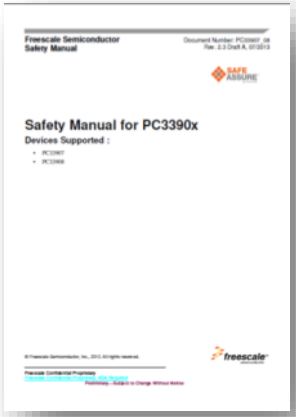
SafeAssure — Safety Manual


Freescale Semiconductor

Safety Manual

Safety Manual for PC3390x

Devices Supported :

- PC33907
- PC33908

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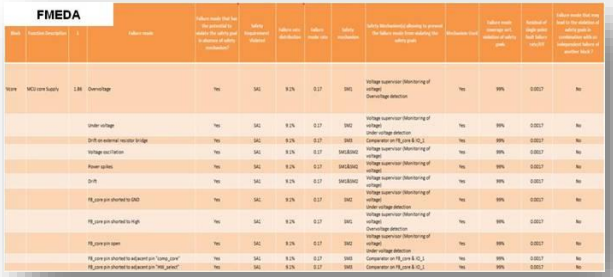
SafeAssure — FMEDA


FMEDA

White Paper


White Paper

Safety-Integrated Hardware Solutions to Support ASIL-D Applications

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Abstract

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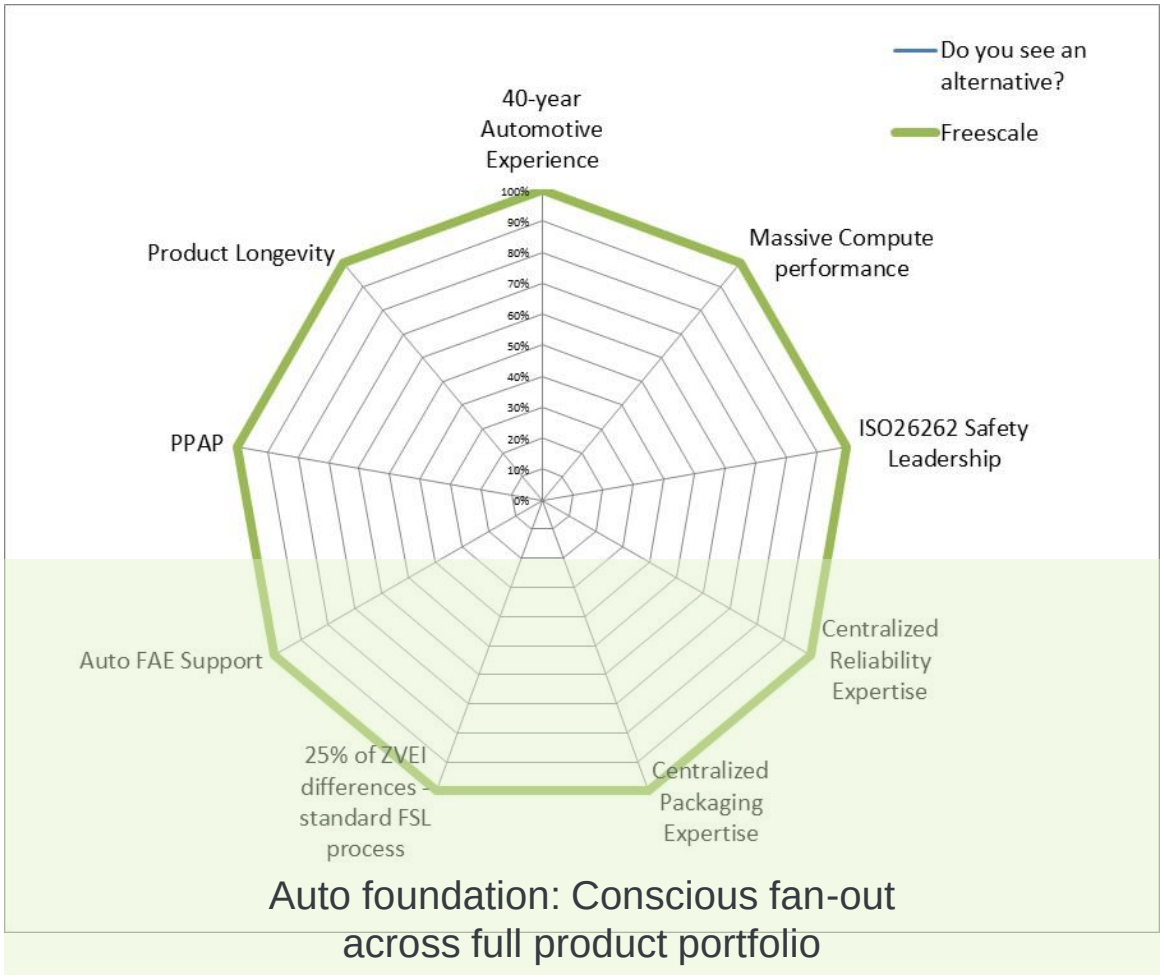
Freescale Differentiated Value Creation Towards Autonomous Driving



Auto foundation: Conscious fan-out across full product portfolio

- Conscious & data driven design-for-reliability & quality decisions
  - Across portfolio
  - Re-assess different mission profiles
  - Understanding implications of our decisions
- Extended technology certification — support application design margin
- Safe Assure Safety leadership — Product, Software, Documentation, Support
  - Certified R&D processes for safety products
  - Understanding implications of gaps
- Quality support e.g. FA / 8D
- Product longevity — 10 years (ind./networking) & 15 years (auto)
- Std. Processes accross Freescale:
  - FMEA, DFMEA, PFMEA, subcon management, EOL, IMDS, excursion elimination, reliable NPI flow, TS16949

Autonomous Driving - Crossroad

Autonomous Driving will change the Automotive world completely & creates substantial new hardware challenges that need attention by Tier1 and CarOEM.

Component selection risks do not only impact companies, but might lead to direct, personal consequences for the responsible employee or manager.

- **Freescale offers differentiated strategies across the complete required performance range**
- **Customer value comes from product, but even more from supplier capability**
- **Success factor: data driven risk identification & understanding implications based on conscious Freescale decisions**
- **Which partner do you trust helping you towards solutions that will autonomously drive your children?**

www.Freescale.com