

Parallels - Communication Challenges and Opportunities In-Vehicle and in Manufacturing

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Why a Comparative Look?

Sharing across market sectors can help address impediments to technology introduction and acceptance.

Industrial Technology

Impediments to Introductions

[Concerns about]

- Reliability
- Efficiency
- Cost
- Security
- ...

-- Cena, Valenzano, & Vitturi
IEEE Industrial Electronics Magazine
March 2008

In-Vehicle / In-Manufacturing

Comparisons & Contrasts

- General Environment
- Lifecycles
- Areas of Opportunity

In-Vehicle / In-Manufacturing

General Similarities

Metrics

- Reliability
- Efficiency
- Cost
- Security

Environments

- Temperature: not as different as some think ...
- Shock/Vibration: factories involve movement!
- EMC

Environmental Similarities

Multipath

- Industrial scenario: wireless in the factory
 - Attractions:
 - Reduction of cable trays and conduits
 - Ease of reconfiguration
 - Hurdle: electromagnetic environment
 - Facilities are rarely designed around EM environment.
 - Facility materials affect the EM environment.
 - Distribution of ferromagnetic material is dense.

Environmental Similarities

Multipath

- Automotive scenario: wireless sensing in-vehicle
 - Attractions:
 - Reduction of cabling, cable routing vias/protection/seals, ...
 - Reduction of connectors
 - Flexibility for reconfiguration/re-use in design and production
 - Hurdle: electromagnetic environment
 - Vehicles are rarely designed around EM environment
 - Vehicle materials affect the EM environment
 - With steel unibody, ferromagnetic material distribution is very dense.

***From the perspective of a local coordinate frame,
the problems are the same.***

Environmental Similarities

Wireless Sensing

- Industrial scenario: “Smart” milling cutter
 - Process: maintain torque/speed for cut uniformity
 - Motivation for sensing: monitoring tool health
 - Cutter temperature is indicative of cutting efficiency (dull tools run hot).
 - Preferred sensing location: directly on tool (not on tool holder)

Environmental Similarities

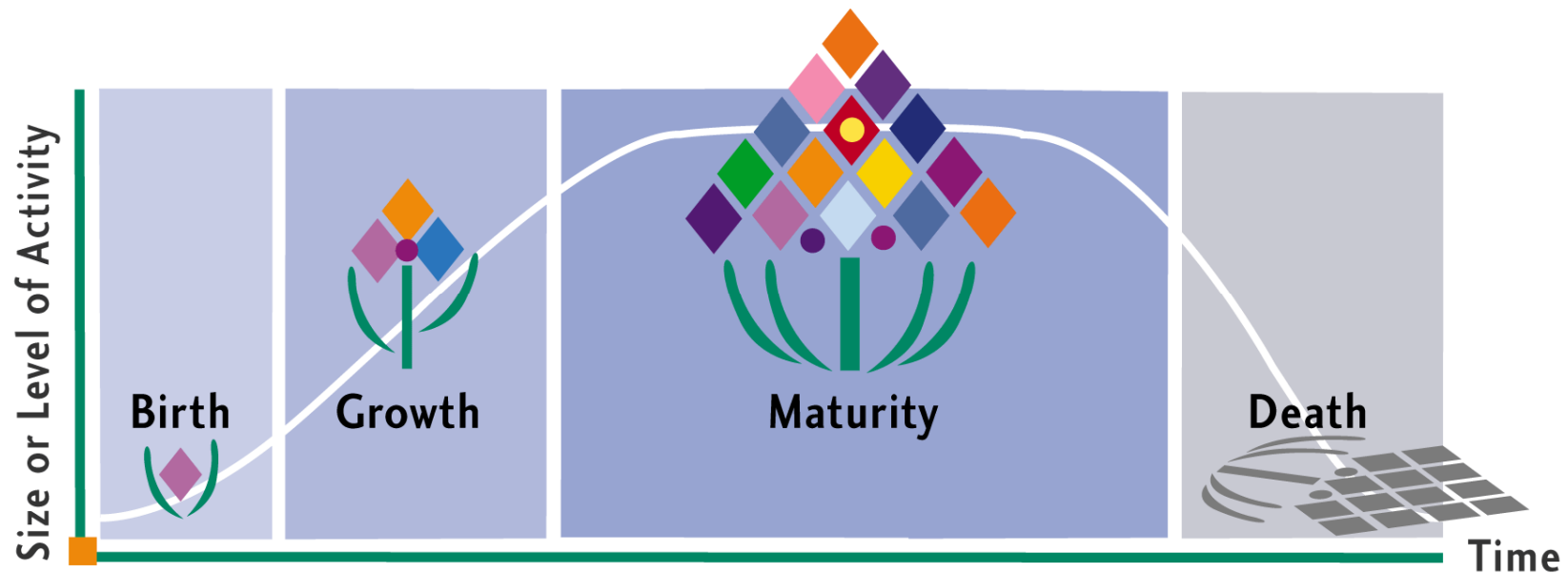
Wireless Sensing

- Automotive scenario: Tire Temperature Monitor
 - Process: maintain torque/speed for propulsion.
 - Motivation for sensing: monitoring tire health
 - Inflation pressure sensing shows background conditions that result in undesirable temperatures.
 - Direct temperature measurement is useful.
 - Preferred sensing location: in the tire.

Again: the problem is topologically the same!

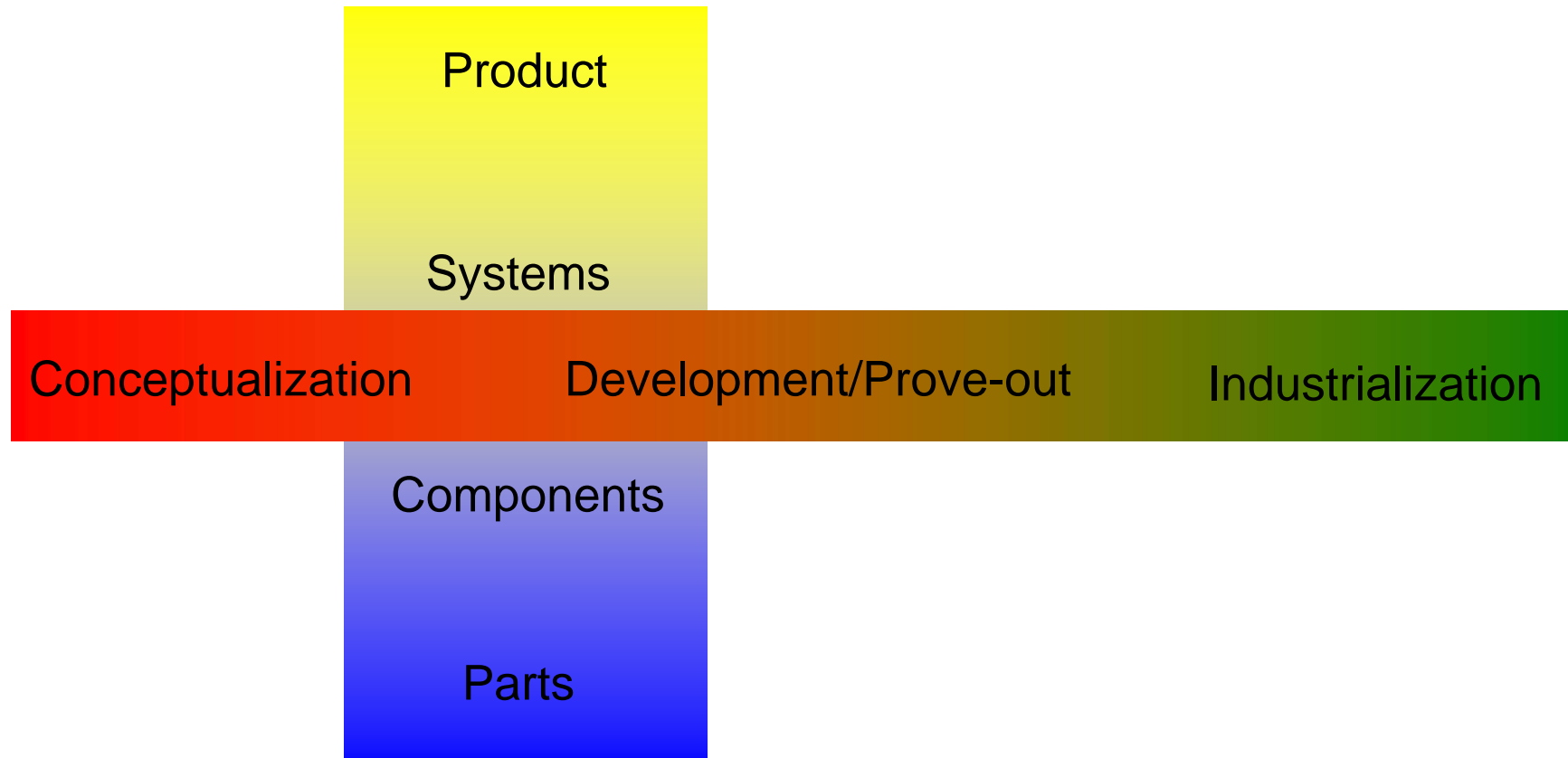
Technology Lifecycle

4-Phase lifecycle: single product



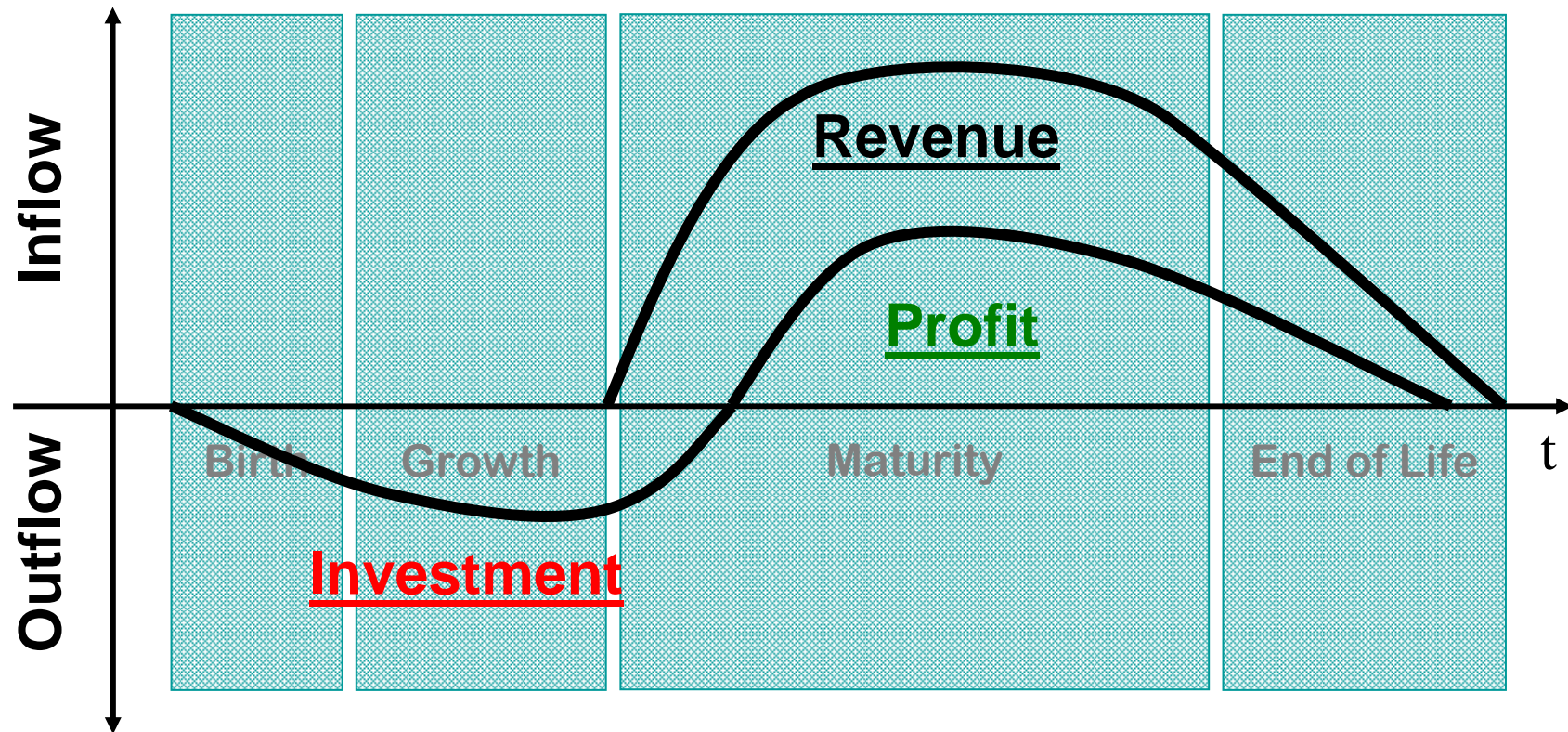
New Technology

Integration Necessary for Introduction



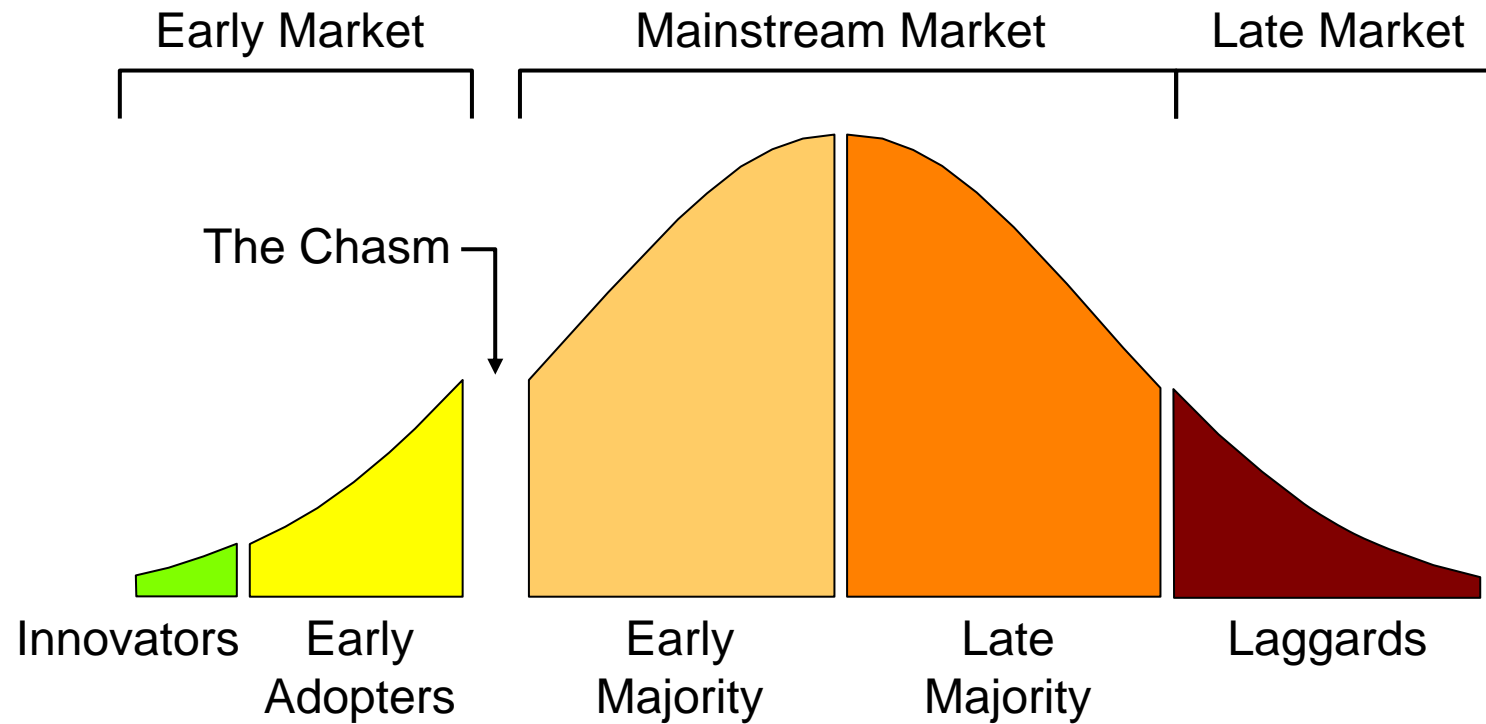
Cash Flow for a Lifecycle

4-phase/single-product



(Adapted from Harold Kerzner's *Project Management*)

Technology Acceptance By Market Groups



Adapted from Geoffrey Moore's *Crossing the Chasm*, 1991

Technology Acceptance

By Market Groups

- Early Market - *must be captured first*
 - Innovators: get technology to be **different**
 - Early Adopters:
 - Get technology to be **ahead of competition**
 - Serve as examples for mainstream
- Mainstream Market - *does not lead change*
 - Early Majority: fast followers
 - Late Majority: trend followers
- Laggards - always behind.

Technology Acceptance

By Market Groups

- Early Market -
 - Technology proficient
 - Complexity is part of getting ahead.
- Mainstream Market -
 - Other factors already create high complexity.
 - Additional complexity is undesirable.

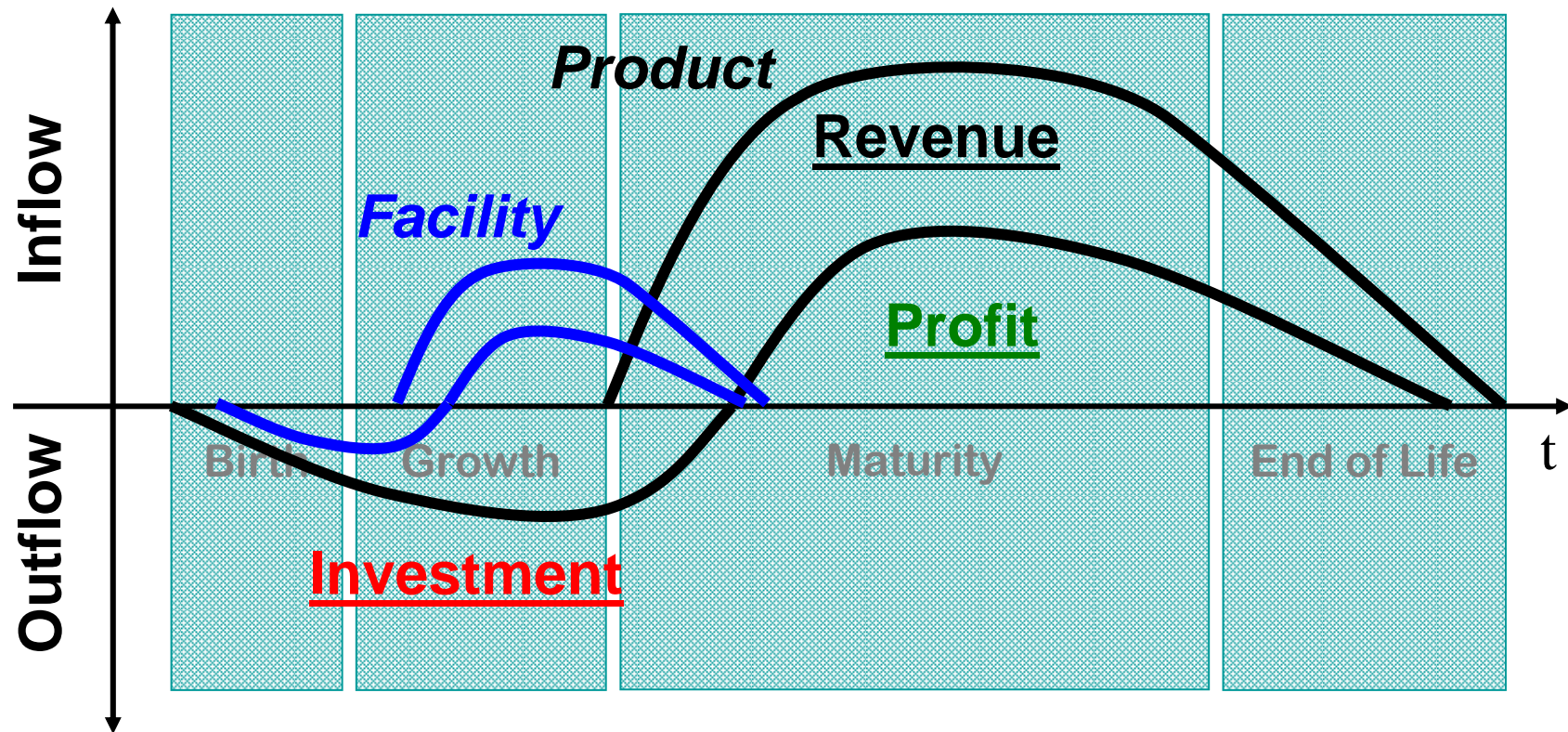
Products need to be different for these two market groups!

Market Characterization

Industrial vs Automotive

- Industrial Technology Cost
 - Lower in volume
 - Operational cost can justify higher unit cost.
 - Depreciable capital investment
- Automotive Technology Cost
 - High volume
 - Low unit cost requirement
 - Non-depreciable consumer purchase

Coupled Cash Flows



(Adapted from Harold Kerzner's *Project Management*)

Example: Leveraging Similarities

Controller Area Network (CAN)

- Developed for Automotive; accepted for Industrial applications.
- Robustness by Design
 - Bit-wise error checking
 - Non-destructive Arbitration
 - Cyclic Redundancy checks
- Package/Flexibility Advantages
 - 4-wire bus
 - Compact physical layer

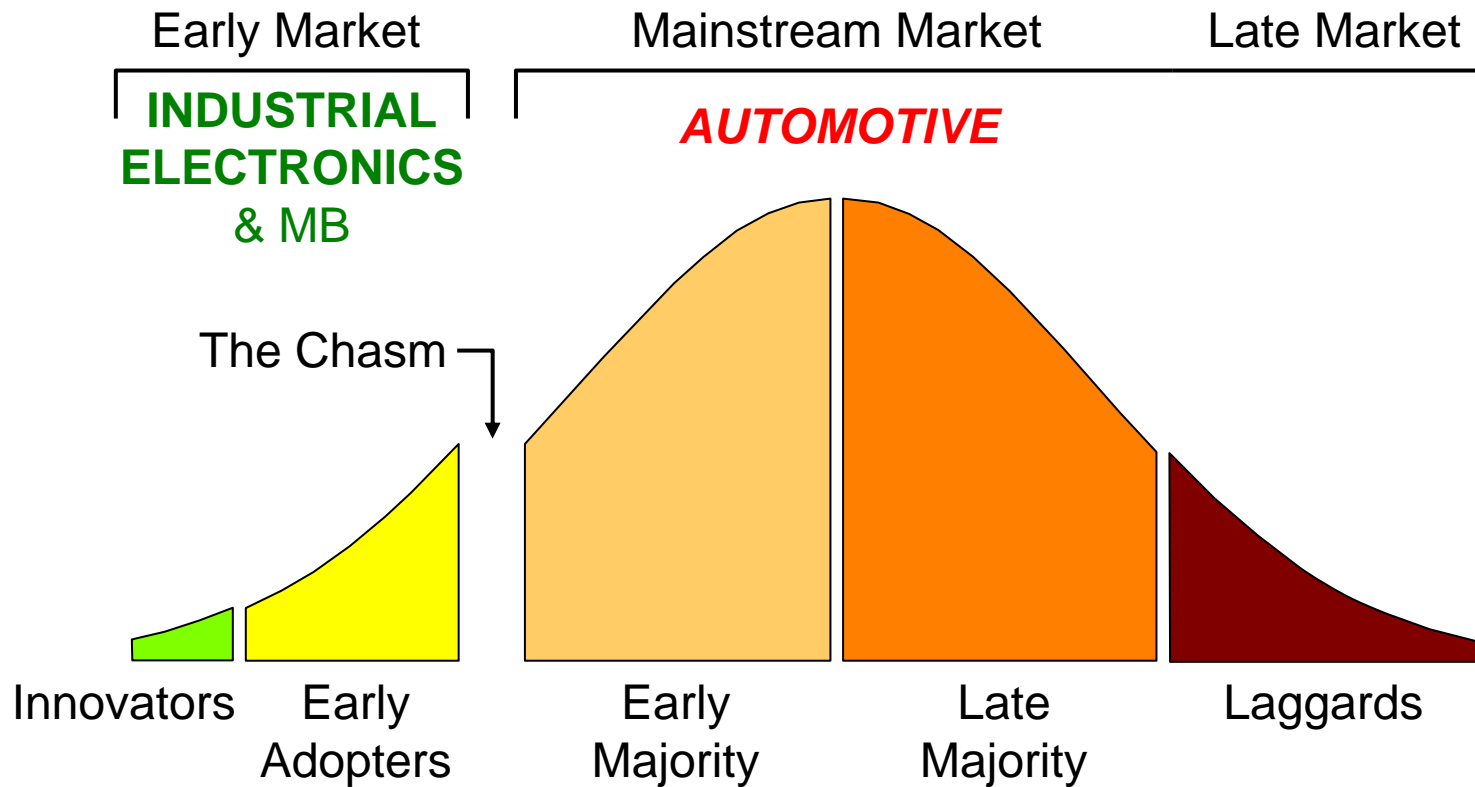
Example: Leveraging Similarities

Controller Area Network (CAN)

- 1983 Development starts at Bosch
- 1986 Introduction at SAE World Congress
- 1992 CAN in Automation formed; Mercedes introduction
- 1993 Allen-Bradley launches DeviceNet; CAN standardized as ISO 11898-1.
- 2000- CAN well-established in automation
- Today Many automakers still in process of adoption ...

Example: Leveraging Similarities

Controller Area Network (CAN)



Adapted from Geoffrey Moore's *Crossing the Chasm*, 1991

Example: Leveraging Similarities

Controller Area Network (CAN)

CAN is proof that technology-sharing across market sectors can help the technology maturity and acceptance process.

Areas of Opportunity

Topics of Potential Synergy

- Determining part presence in a crowded space.
- Scalable lean information in the factory.

Areas of Opportunity

Part presence in a crowded space

- Industrial: incoming/moving part stack(s)
 - Today: techniques are sufficient to answer
“What is this part?”
 - Tomorrow: questions may be
“Is the part in this group?” or ***“Where is the part?”***
 - Identification technologies
 - Bar-codes and RFIDs: low-cost, but LOS/proximity preferred.
 - Small transceivers: costs of being “awake”?
 - What is the most efficient place to store knowledge of location/presence?

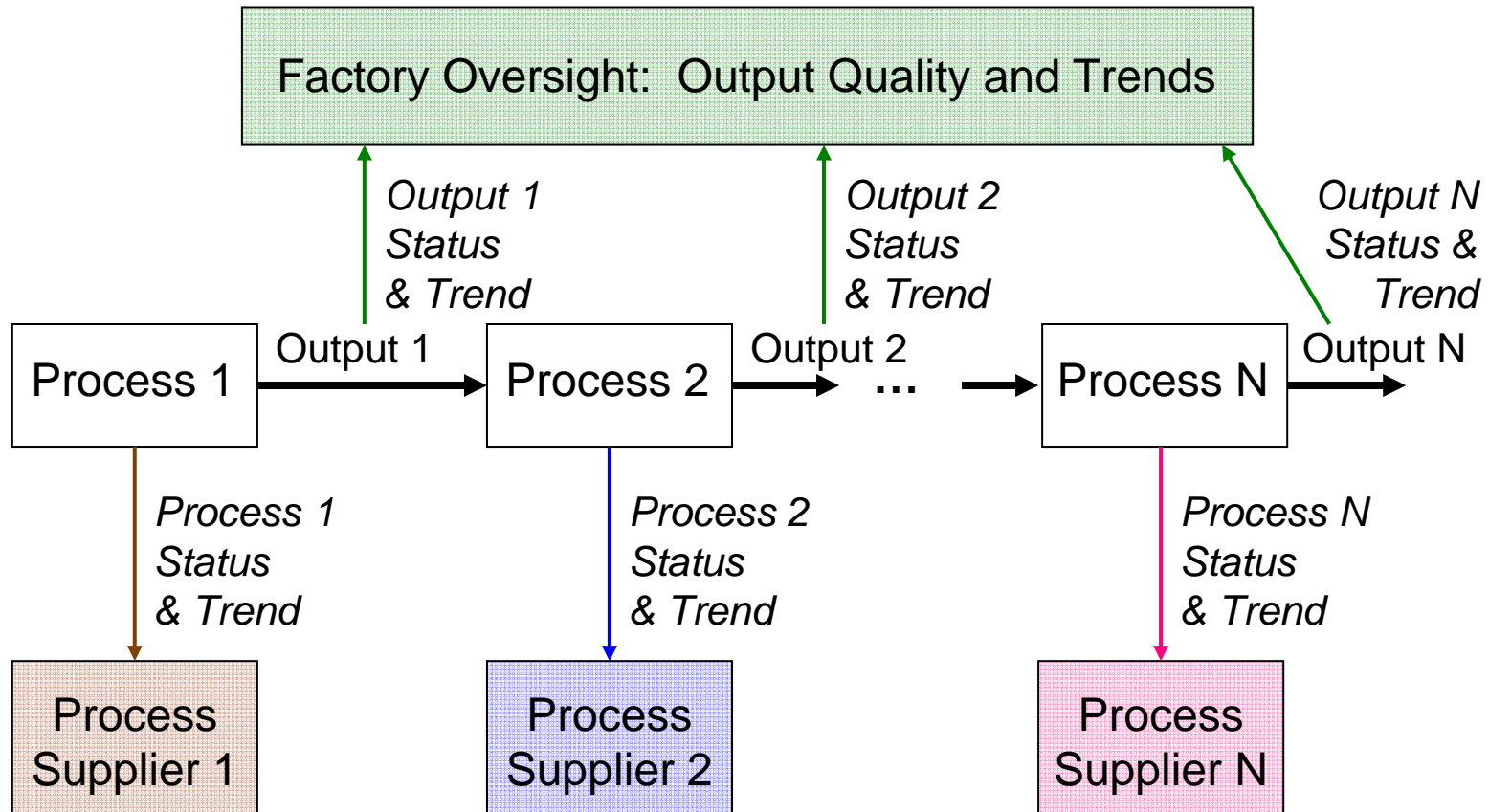
Areas of Opportunity

Part presence in a crowded space

- Automotive: vehicle in-service with potential parts to change
 - OEM only knows initial content.
 - Content after sale is not under OEM control!
 - Is the part-to-replace present?
 - Where is the information best “held”?

Areas of Opportunity

Scalable Lean Information



Areas of Opportunity

Scalable Lean Information: Wireless?

- Industrial scenario
 - Factory needs to monitor outputs of processes and overall sequence performance.
 - Process suppliers need to monitor processes.
 - How does one control overall data capacity?
 - Does the factory include capacity “it” does not “need”?
 - How does one handle data from multiple, adjacent process sequences? “Matrix management” of data?
 - What is a scalable strategy for multiple process suppliers to independently monitor their processes ***at minimal impact to the factory?***

Areas of Opportunity

Lean information in a wireless environment

- Automotive scenario:
 - Trend: outsourcing of functional systems
 - Outsourcing of warranty coverage
 - Informational needs
 - OEMs need to monitor vehicle usage.
 - Tier 1 suppliers will need to monitor systems.
 - How does one manage data transfer capacity for a vehicle?
 - How does one manage data transfer capacity for a vehicle **cluster**?

Thank you for listening
... and thinking!

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