Speed, Data and Ecosystems: Engineering in the 21st Century

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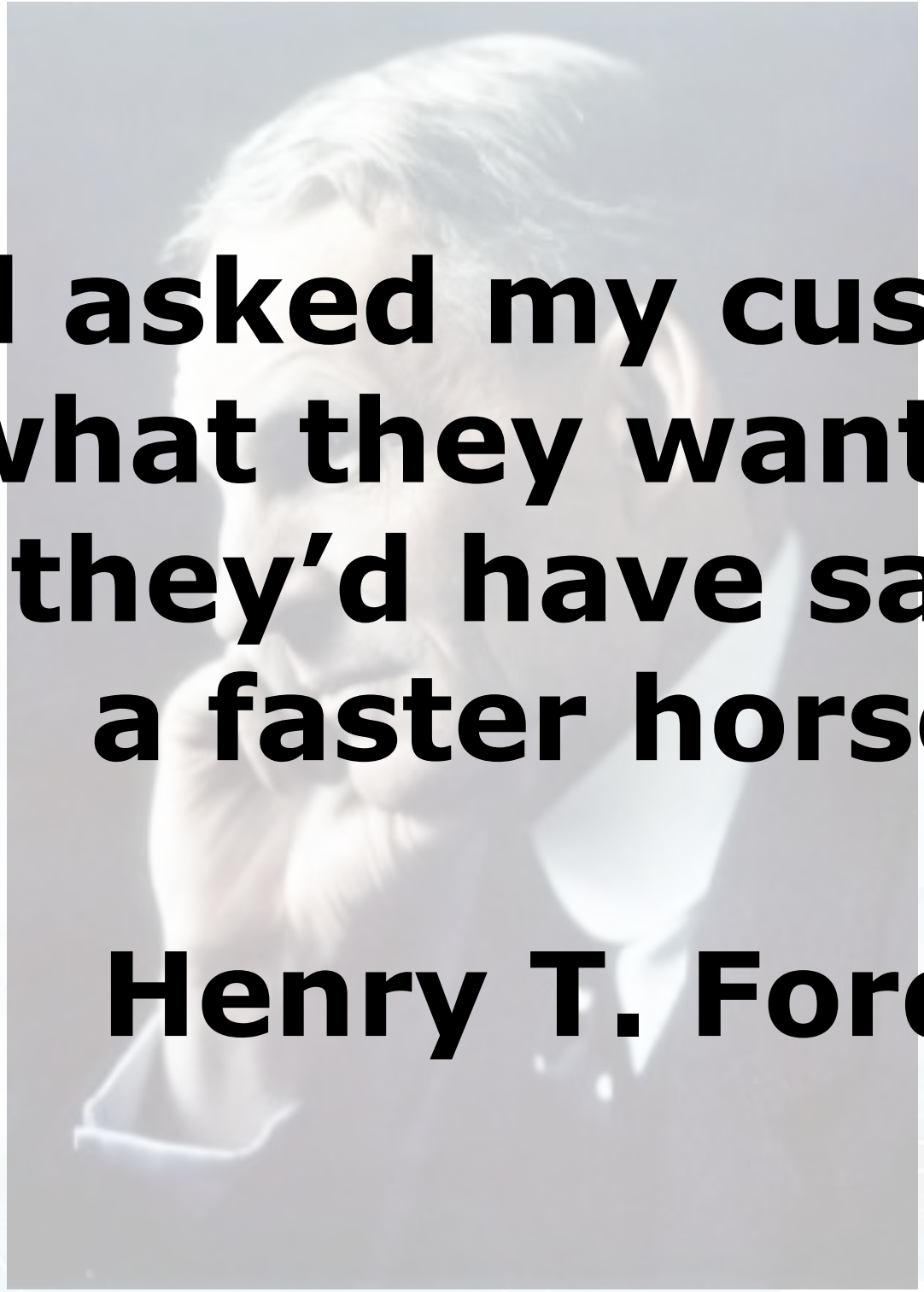
SE Experience, INCOSE Nederland, November 2016



If I'd asked my customers what they wanted, they'd have said a faster horse

Henry T. Ford

Customers don’t know what they want. It’s very hard to envision the solution you want without actually seeing it.

Marty Cagan

The critical failing of user interviews is that you're asking people to either remember past use or speculate on future use of a system

Jakob Nielsen

[The assumption that a] reasonably well-defined set of requirements exists, if only we take the time to understand them, is wrong

Dean Leffingwell

Customers don’t know what’s possible. Most have no idea about the enabling technologies involved

Marty Cagan

You can't just ask customers what they want and then try to give that to them. By the time you get it built, they'll want something new.

Steve Jobs

Underlying Insight

- Customers don’t know what they want
- You need to you show “it” to them
- And then measure their behaviour
- Or, if you must, talk to them

Three Key Take-Aways

- Increasing **SPEED** trumps ANY other improvement R&D can provide to the company – the goal is **continuous deployment** of new functionality
- Effective use of **data** from customers and products in the field is the next area to exploit and monetize
- Strategic use of the **ecosystems** around your systems and services is critical as it allows for agility, risk sharing and allows the company to focus on the key differentiators

Overview

- Vem är jag? Wie ben ik? Who am I?
- Trends in Industry: Need for Speed
- Stairway to Heaven
  - Speed
  - Data
  - Ecosystems
- Implications for Systems Engineering
- Conclusion

Academic Research

10X Software Center

Software Center

Consultancy

ERICSSON · BOSCH · SIEMENS · BASF · GRUNDFOS · SONY · JEPPESEN · THALES · VARIAN · AirTies · transmode · SEB

Entrepreneur

fidesmo · Remente

Industry Innovation

intuit · NOKIA

AUQTUS
Automated Quality Testing of User Scenarios

Industry Operations

NOKIA

Software Center

Mission: Improve the software engineering capability of the Nordic Software-Intensive industry with an order of magnitude

Theme: Fast, continuous deployment of customer value

Success: Academic excellence

Success: Industrial impact

CHALMERS

MALMÖ UNIVERSITY

MÄLARDALEN UNIVERSITY
SWEDEN

SIEMENS

verisure
ALARMS WITH IQ

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COMMUNICATIONS

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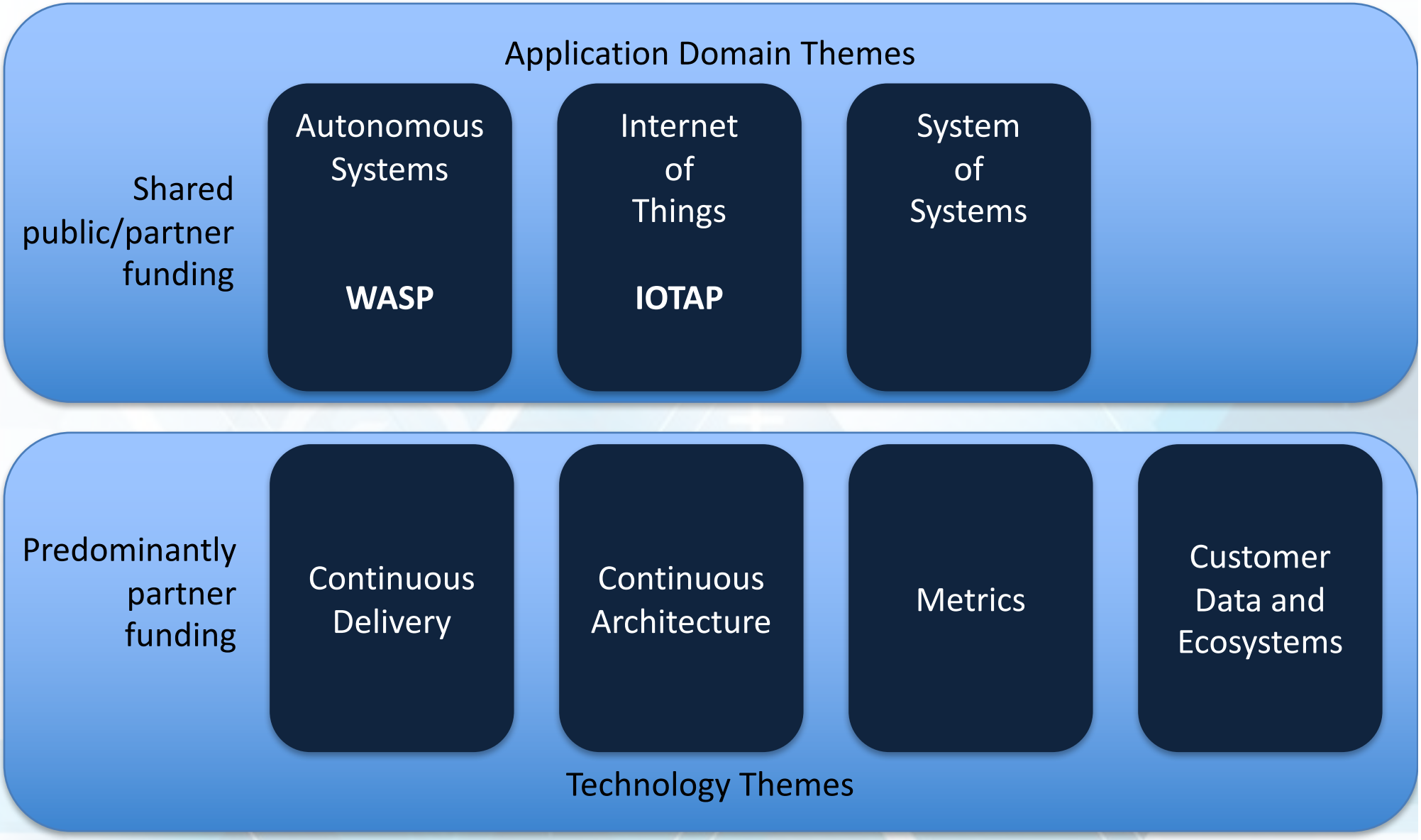
Research Themes



Some Online Companies

Klarna
Simplifying Buying

bing

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Software Changes Everything

Gripen Drone

Air Pollution

Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

Smartphones Detection

Detect iPhone and Android devices and in general any device which works with Wifi or Bluetooth interfaces.

Electromagnetic Levels

Measurement of the energy radiated by cell stations and and WiFi routers.

Smart Roads

Warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Smart Lighting

Intelligent and weather adaptive lighting in street lights.

Water Leakages

Detection of liquid presence outside tanks and pressure variations along pipes.

Vehicle Auto-diagnosis

Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

Item Location

Search of individual items in big surfaces like warehouses or harbours.

Smart Parking

Monitoring of parking spaces availability in the city.

Golf Courses

Selective irrigation in dry zones to reduce the water resources required in the green.

Water Quality

Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

Quality of Shipment Conditions

Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.

libelium
www.libelium.com

Nature of Product Innovation is Shifting

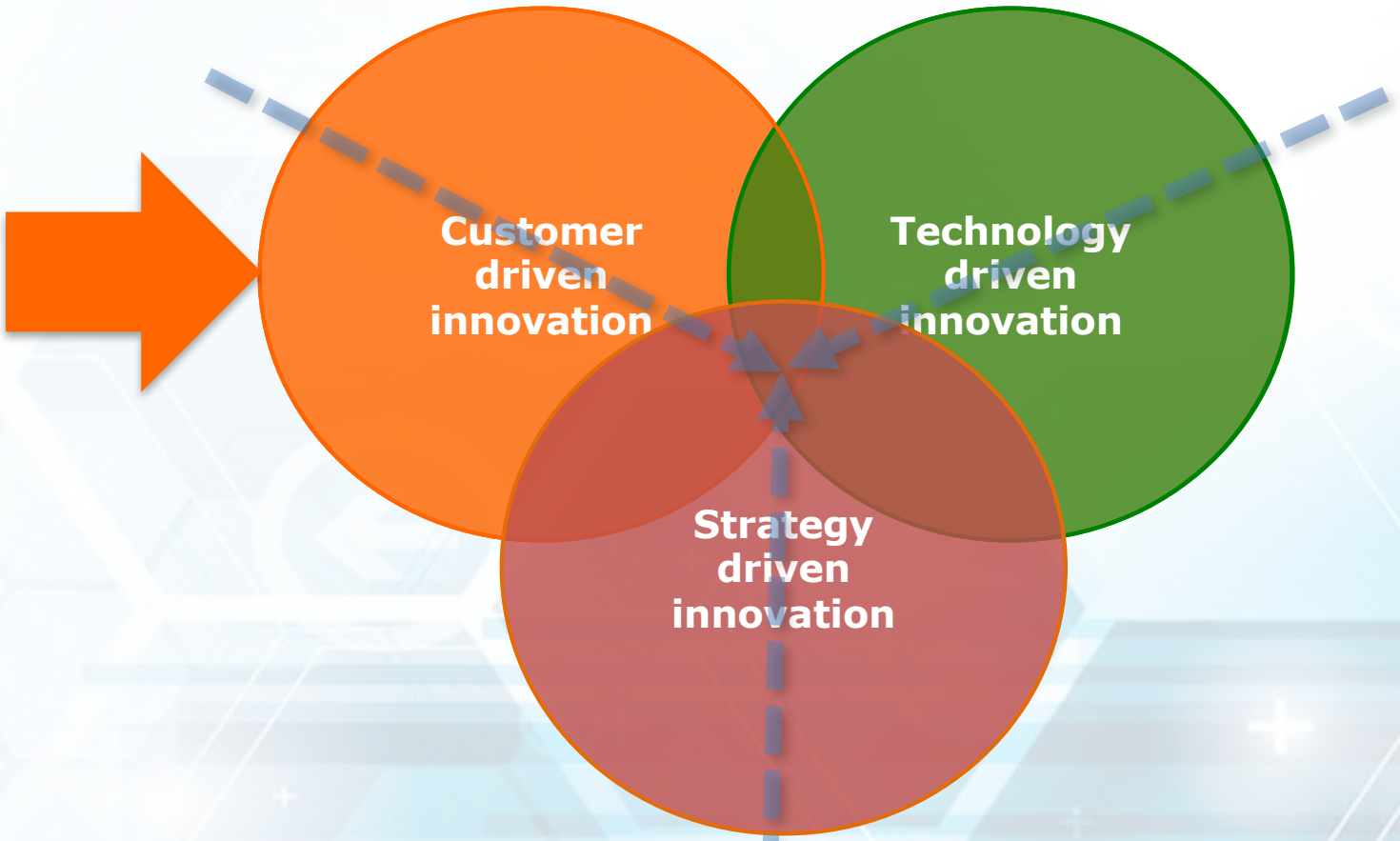
- More than 90% of R&D is related to software according to Ericsson
  - The world's 5th largest software company
- 70% of all innovation is related to software according to AB Volvo
- 80-90% of all innovation in a car is related to electronics (HW & SW) according to Volvo Cars

https://hbr.org/2015/06/does-hardware-even-matter-anymore

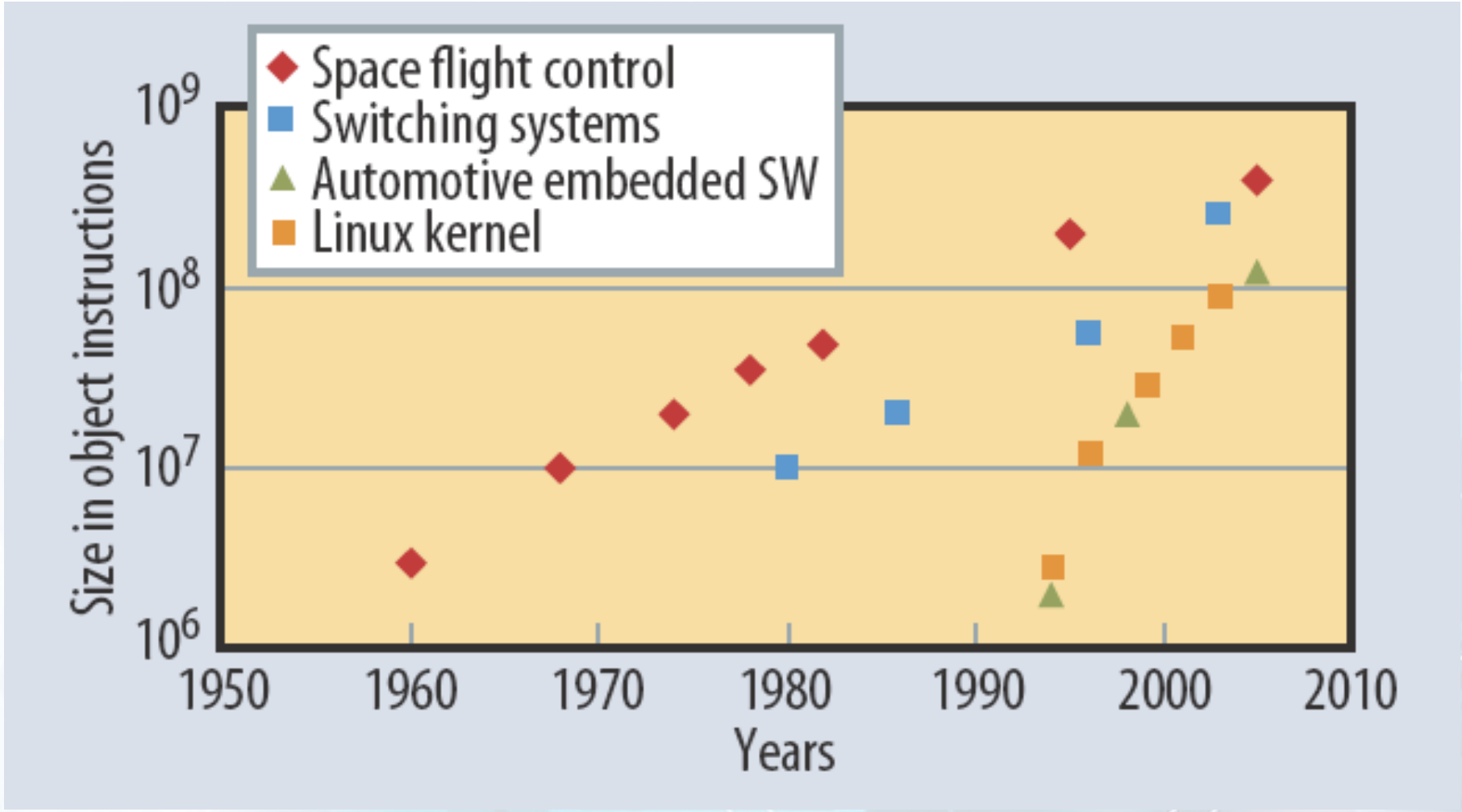
Towards Product as a Service

This requires continuous deployment throughout the lifetime of the product

Innovation Approaches

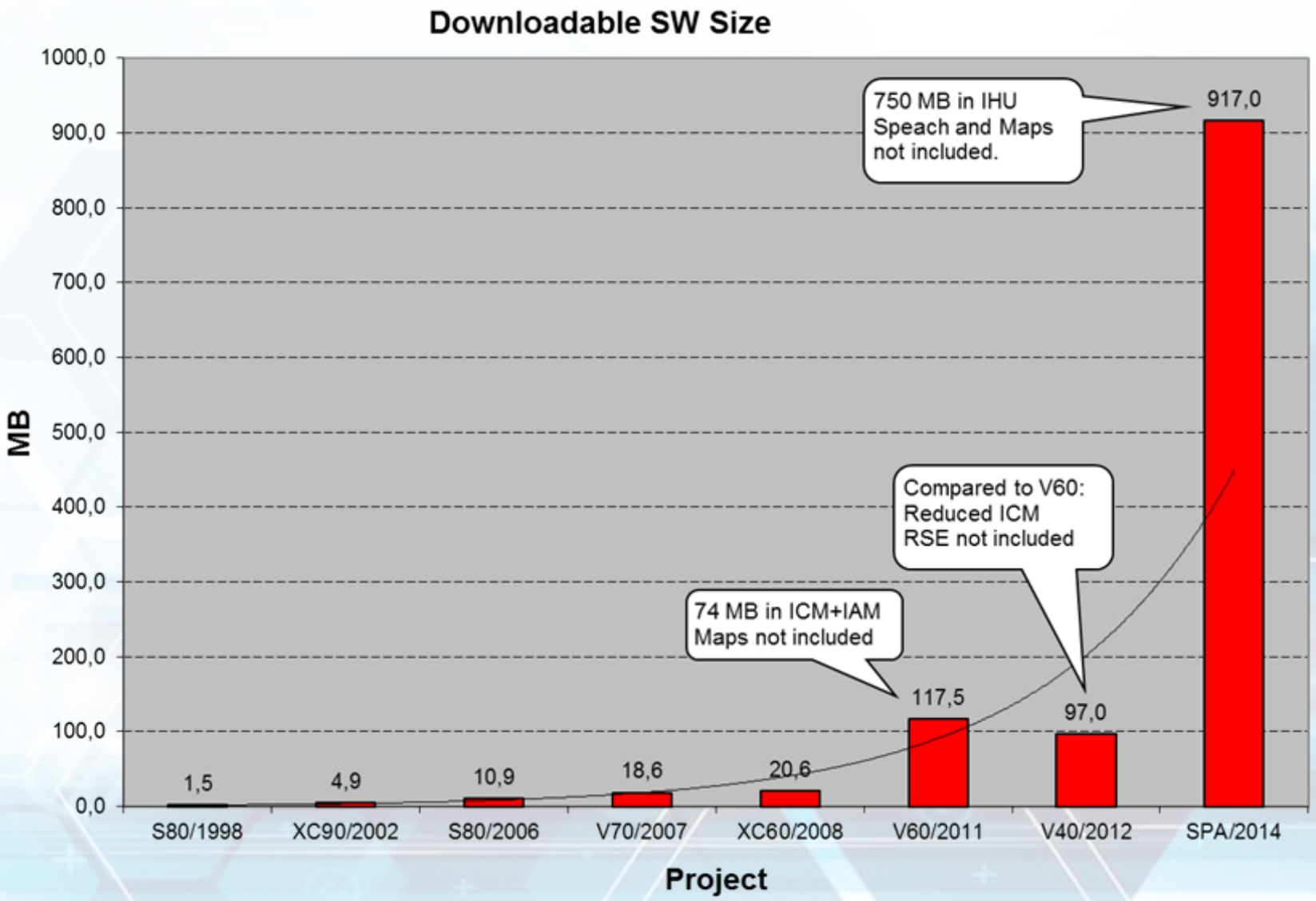


This requires continuous experimentation with customers



10x every ~7 years

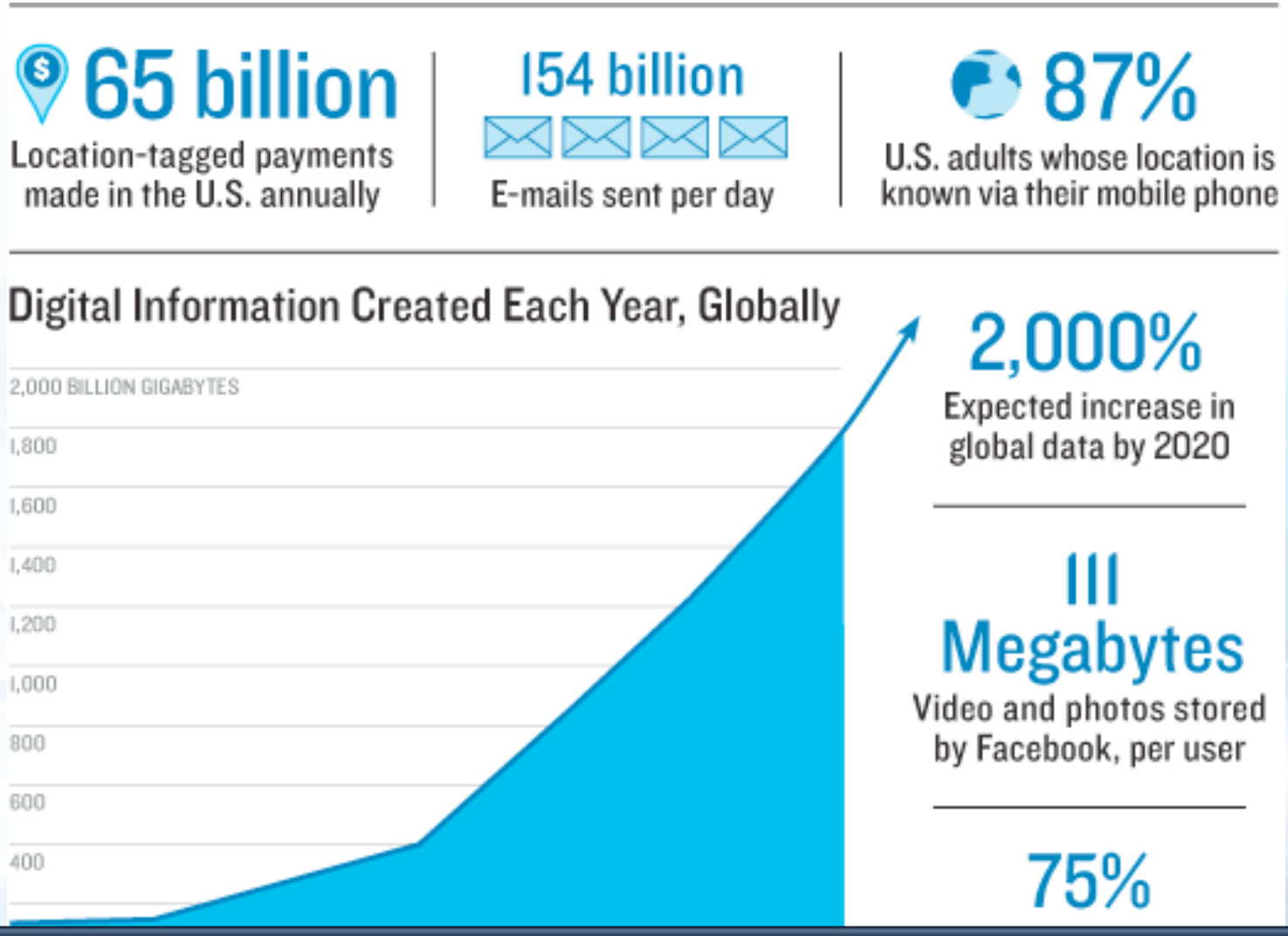
Volvo XC 90


Downloadable SW Size
MB
1000,0
900,0
800,0
700,0
600,0
500,0
400,0
300,0
200,0
100,0
0,0
750 MB in IHU
Speach and Maps
not included.
917,0
Compared to V60:
Reduced ICM
RSE not included
74 MB in ICM+IAM
Maps not included
117,5
97,0
1,5
4,9
10,9
18,6
20,6
S80/1998
XC90/2002
S80/2006
V70/2007
XC60/2008
V60/2011
V40/2012
SPA/2014
Project

Volvo Cars

- 90% of innovations in “electronics and SW”
- Moving major parts of SW development in-house
- Connected cars get updated with new functionality every 2 days
- Volvo has defined the “system scope” to include the car, the cloud services and the mobile apps

Data Generated in the World



50 Terabytes of data are created every second

Trend: Need for Speed

Value Creation Shifts

Emerging companies highlight importance
of user contribution and social connectedness

Level of User Contribution

Founded	1984	1995	2004	2009
1M users	~6 years	30 months	10 months	?
50M users	N/A	~80 months	~44 months	~ 1 month

Need for Speed in R&D – An Example

- Company X: R&D is **10%** of revenue, e.g. 100M$ for a 1B$ product
- New product development cycle: **12 months**

- Alternative 1: improve efficiency of development with 10%
  - **10 M$** reduction in development cost
- Alternative 2: reduce development cycle with 10%
  - **100M$** add to top line revenue (product starts to sell 1.2 months earlier)

No efficiency improvement will outperform cycle time reduction

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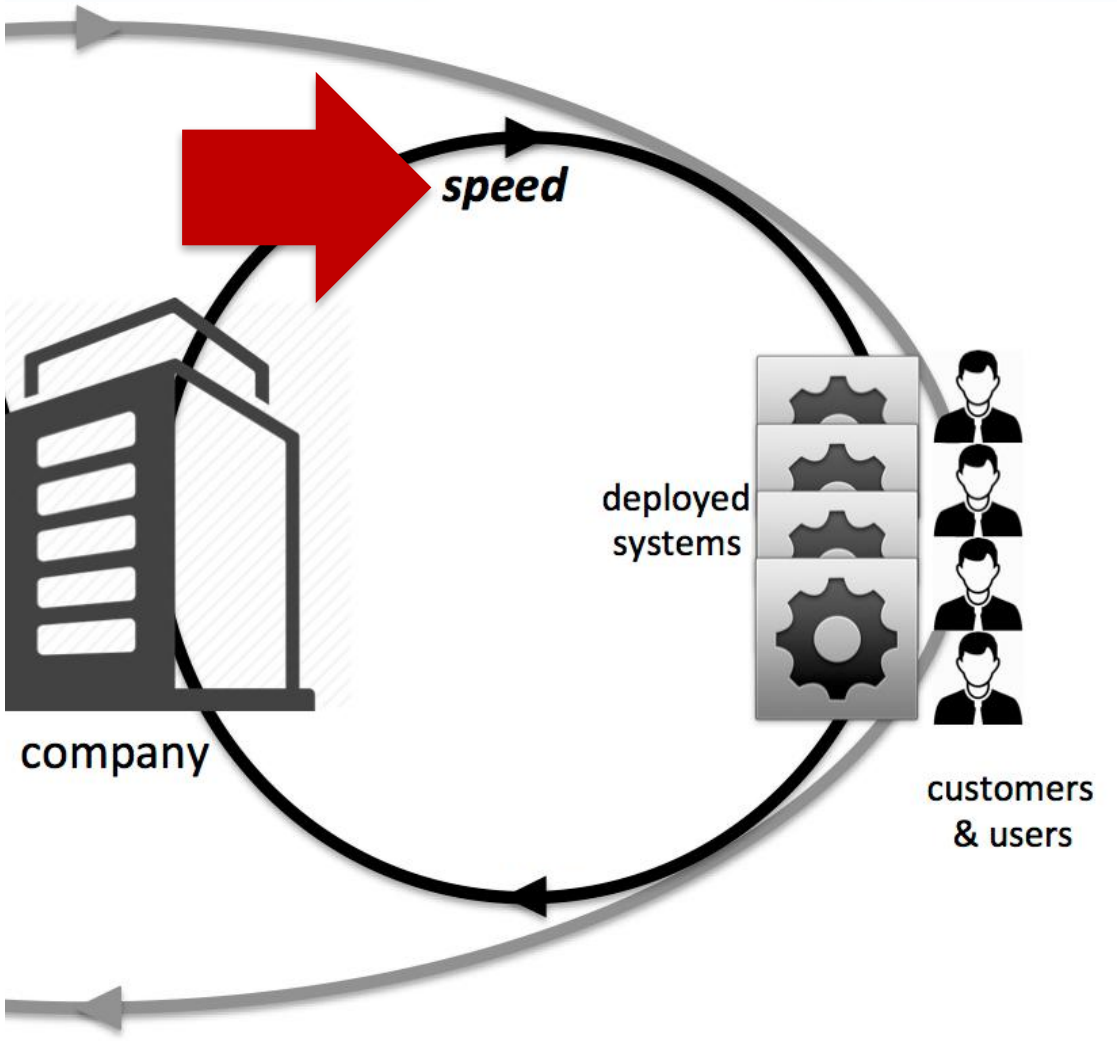
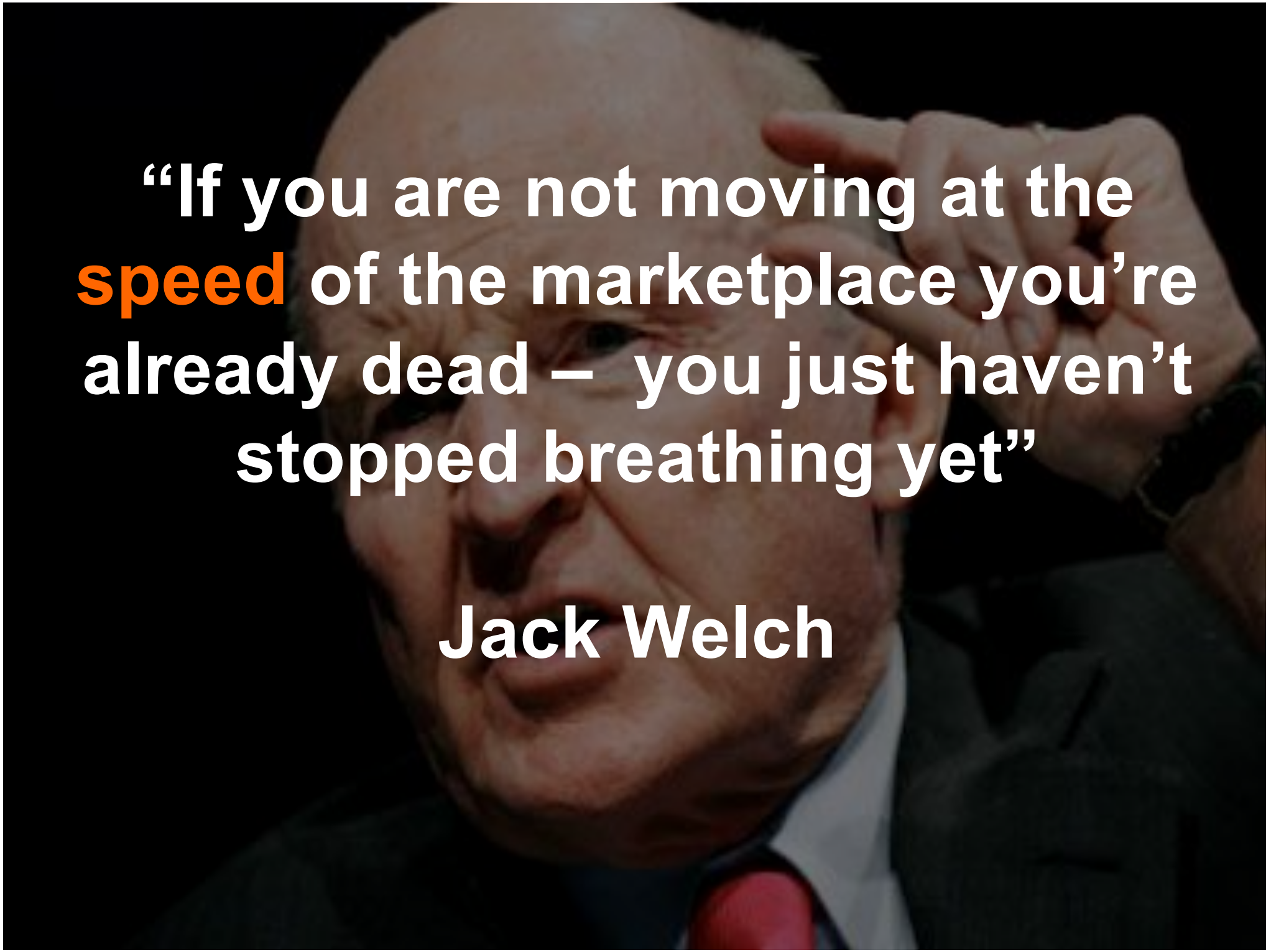
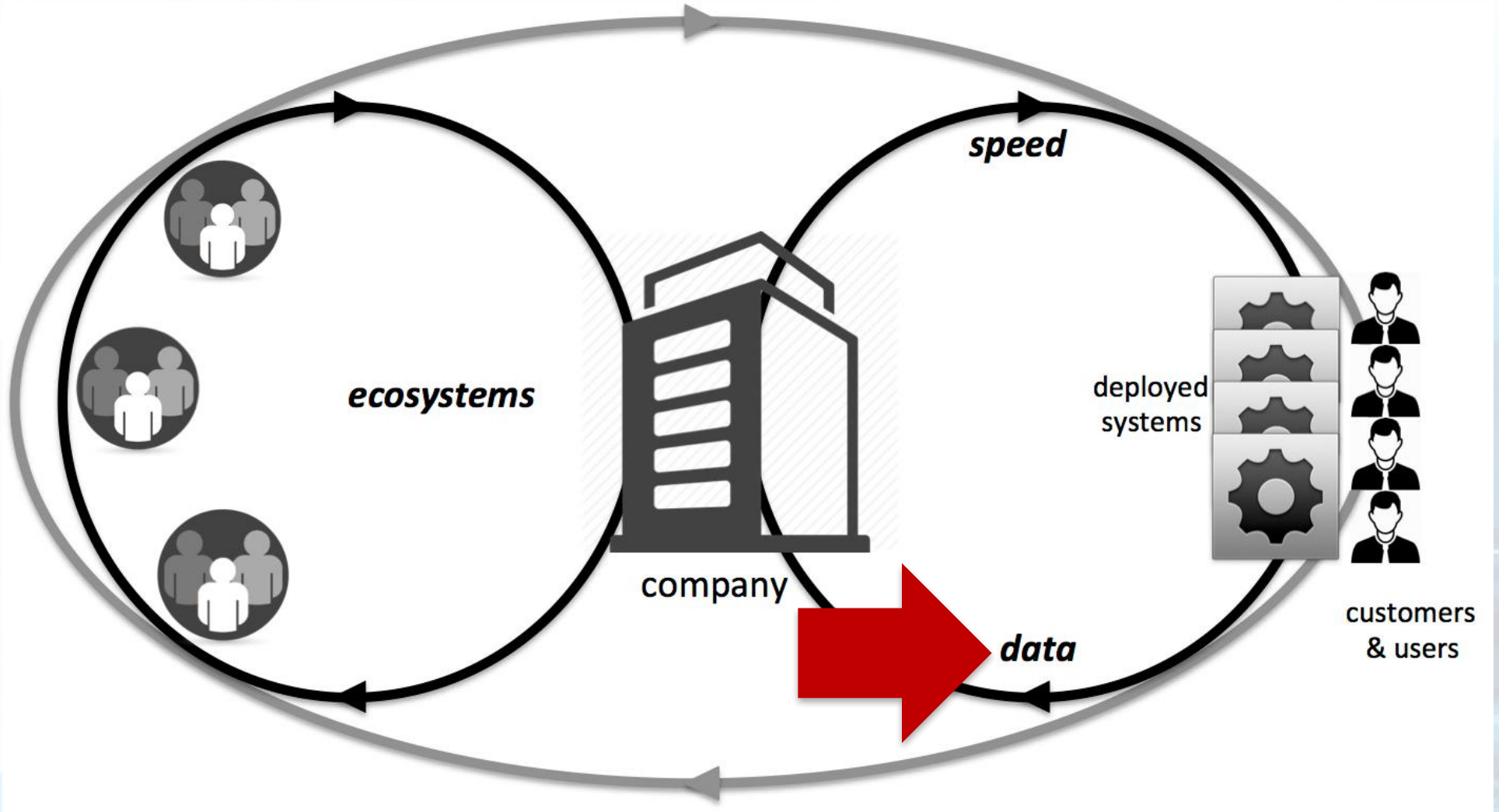
Stairway to Heaven 2.0

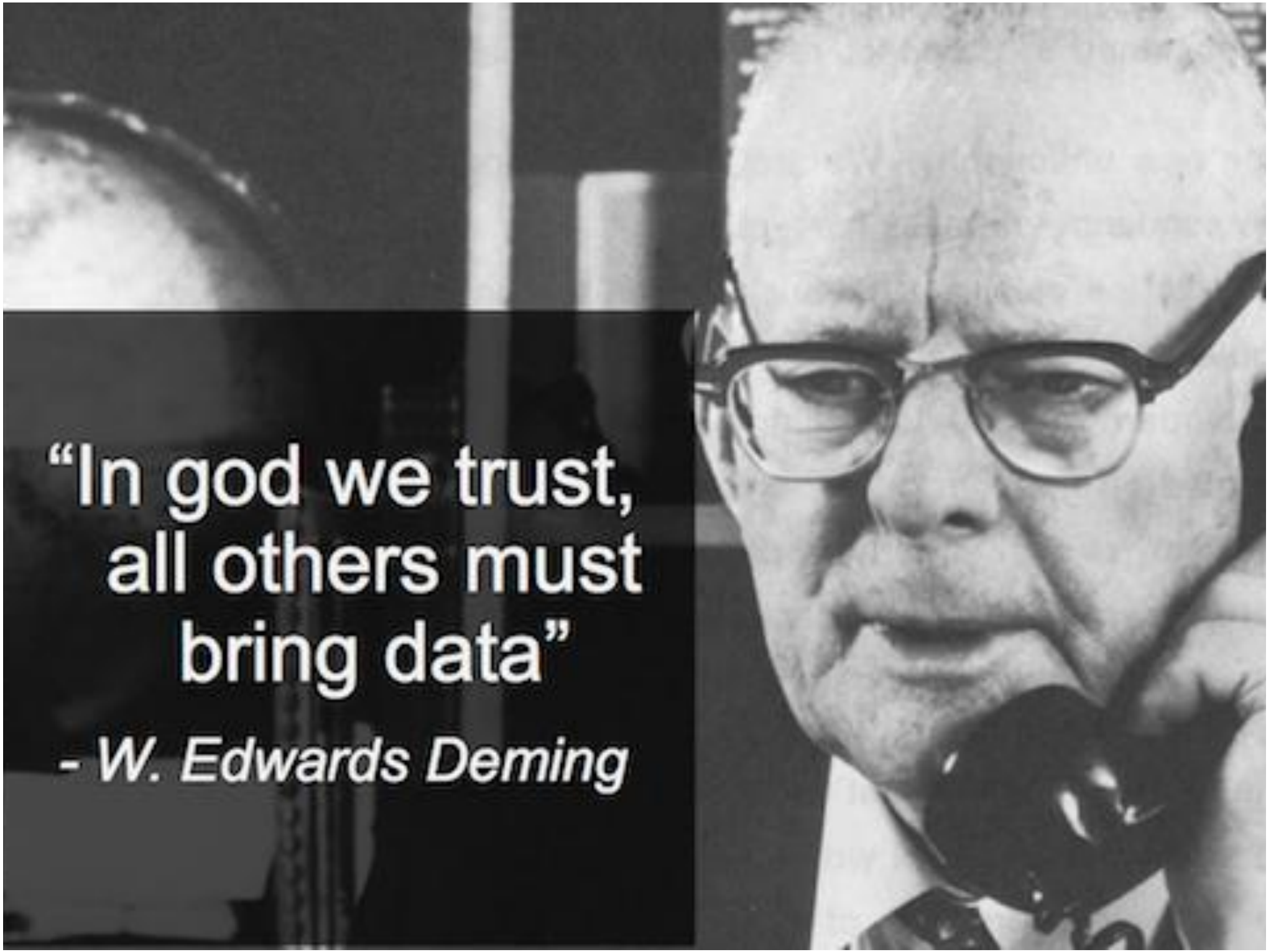



“If you are not moving at the speed of the marketplace you’re already dead – you just haven’t stopped breathing yet”
Jack Welch

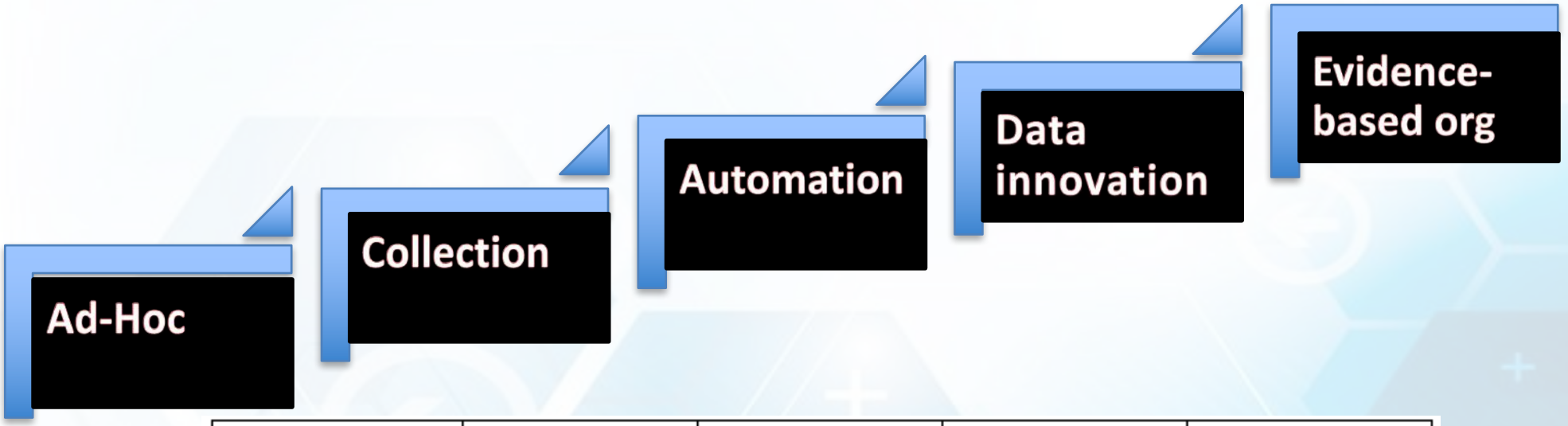
Stairway to Heaven: Speed

Stairway to Heaven 2.0



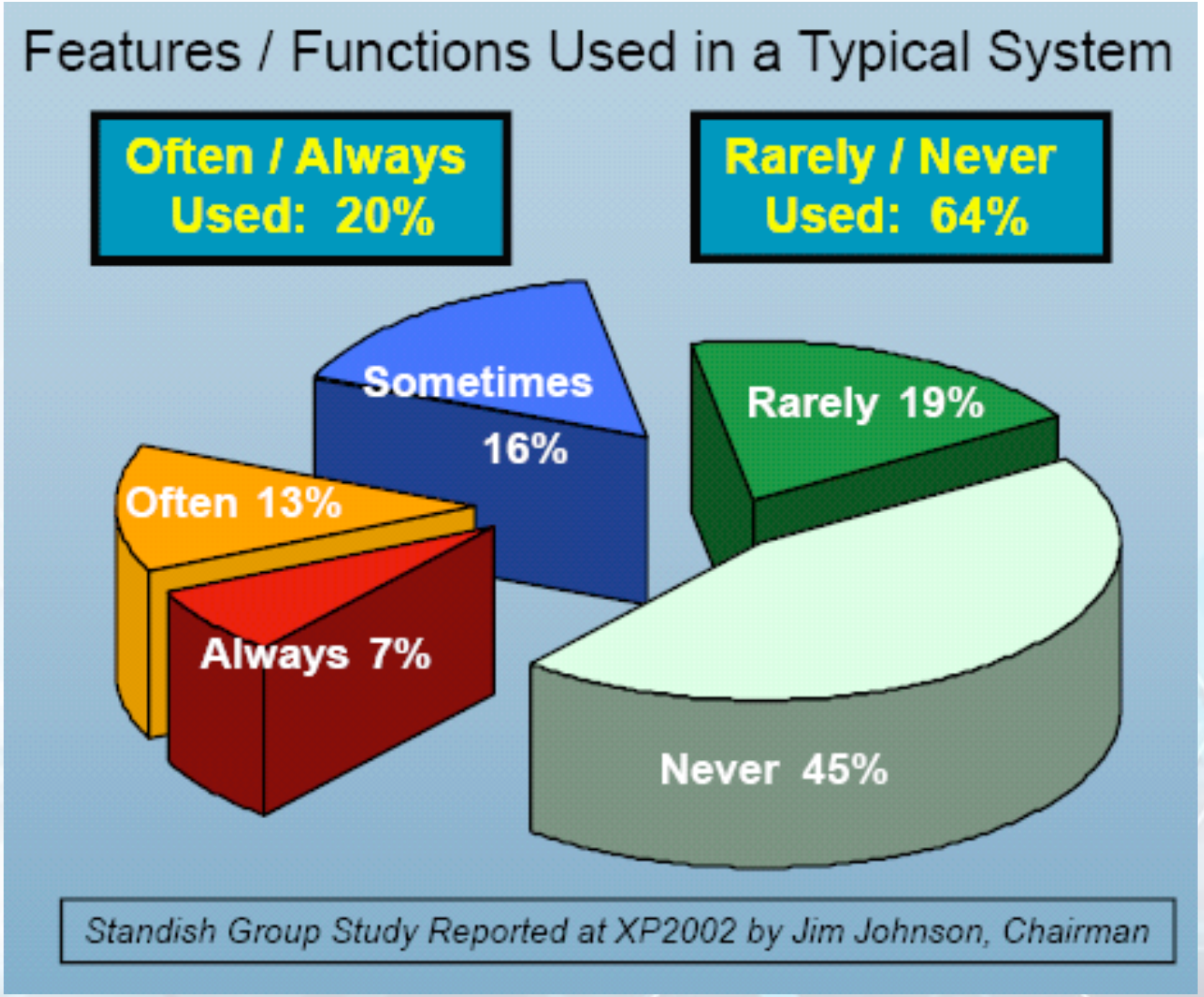

"In god we trust,
all others must
bring data"
- W. Edwards Deming

Stairway to Heaven: Data

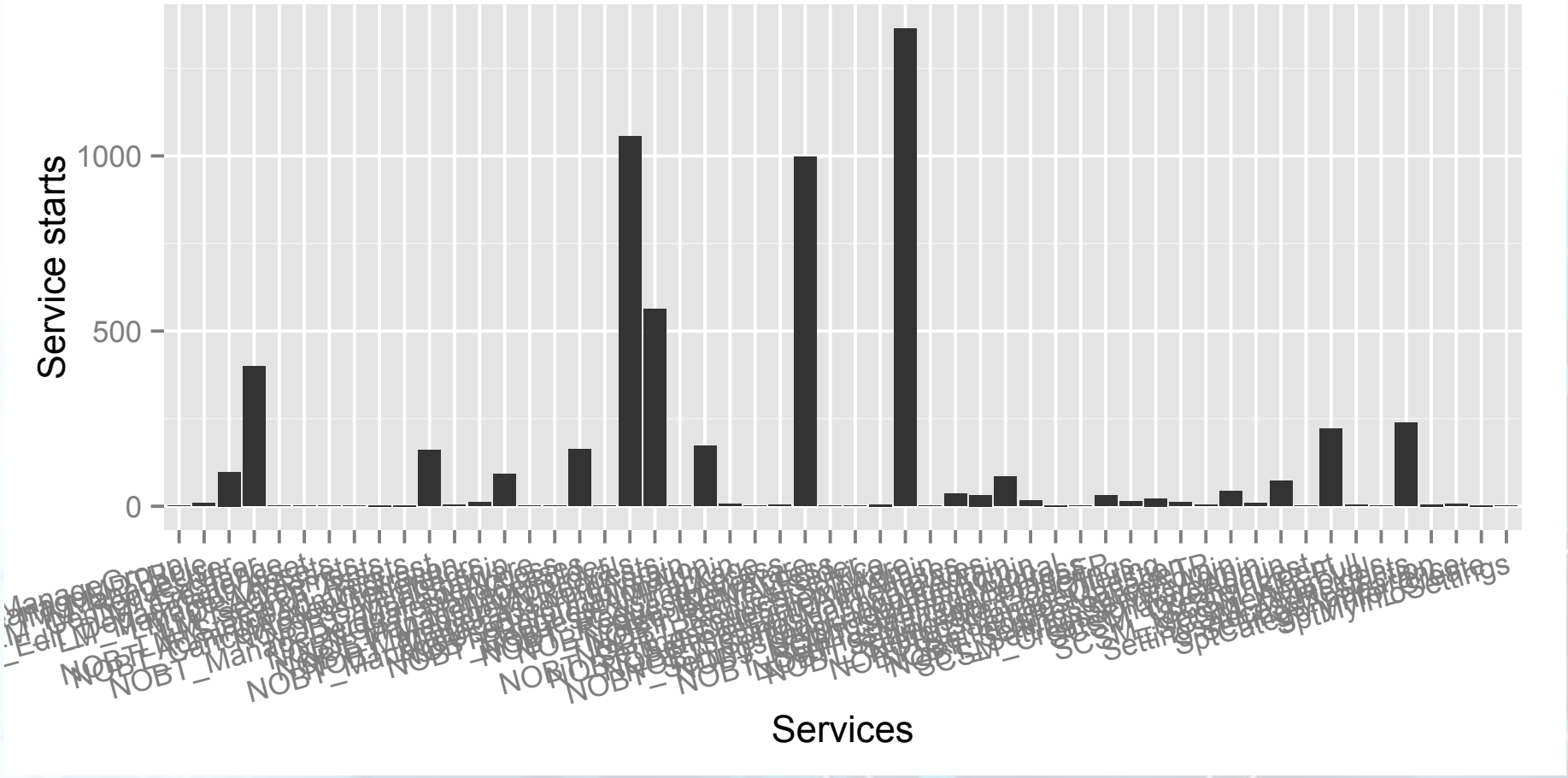


	Collection	Analysis	Reporting	Decision making
Ad-hoc	manual	manual	manual	manual
Collection	automated	manual	manual	manual
Automation	automated	automated	automated	supported
Data innovation	dynamic	dynamic	dynamic	supported
Evidence-based company	dynamic	dynamic	dynamic	automated

“Featuritis”


Features / Functions Used in a Typical System
Often / Always Used: 20%
Rarely / Never Used: 64%
Sometimes 16%
Rarely 19%
Often 13%
Always 7%
Never 45%
Standish Group Study Reported at XP2002 by Jim Johnson, Chairman

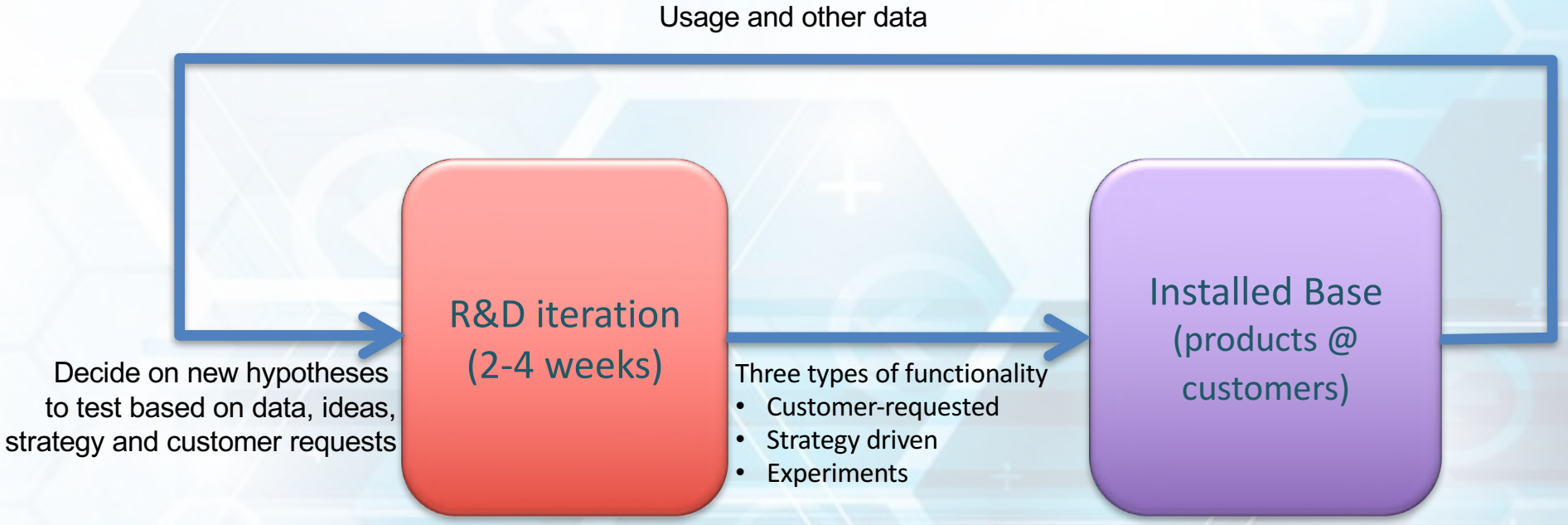
Our Research …



R&D as an Experiment System

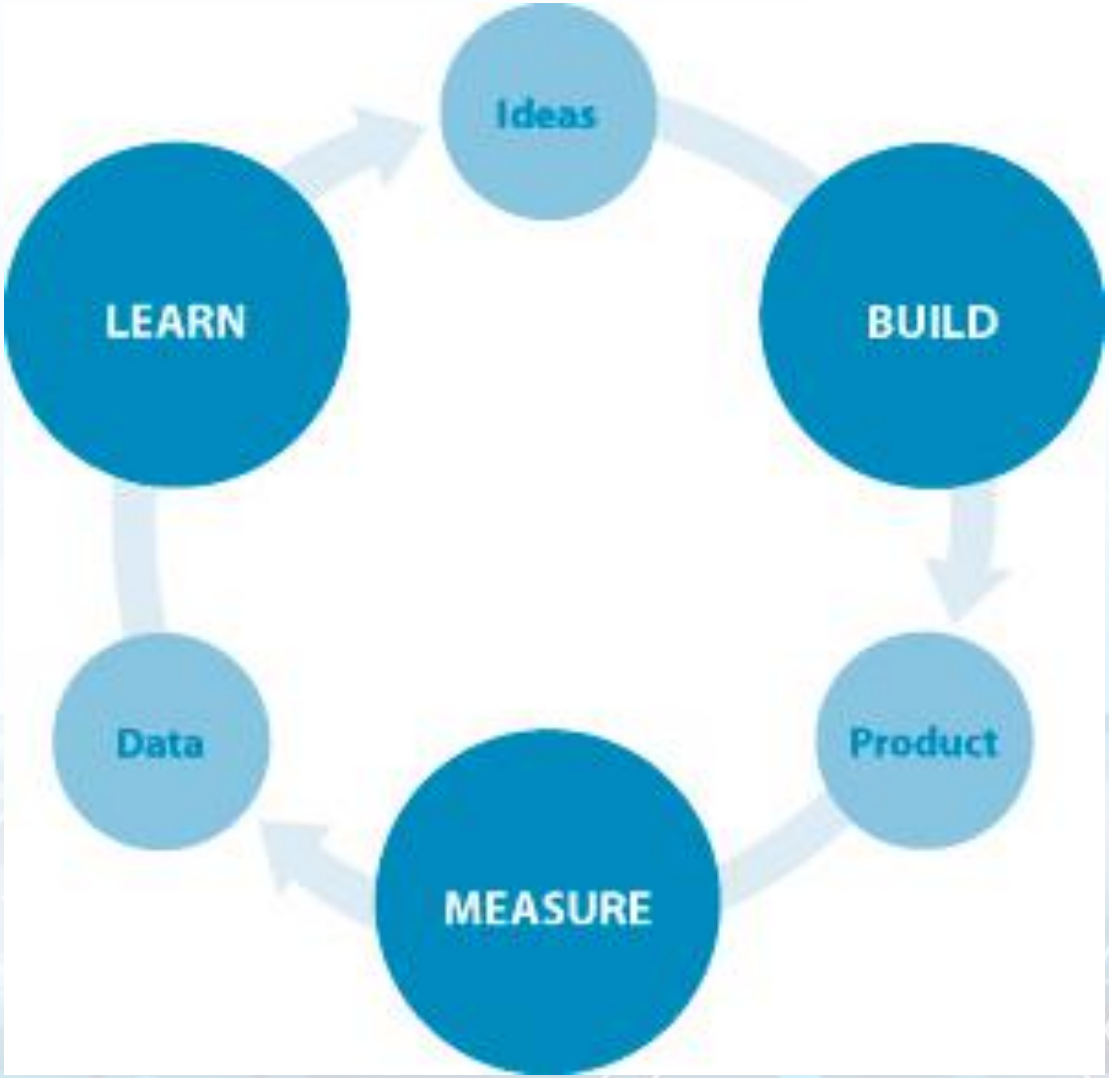
Learning: the company running the most experiments against the lowest cost per experiment wins

Goal: increase the number of experiments (with customers) with an order of magnitude to ultimately accelerate organic growth



Decisions should be based on DATA, not opinions

The Cycle of Innovation



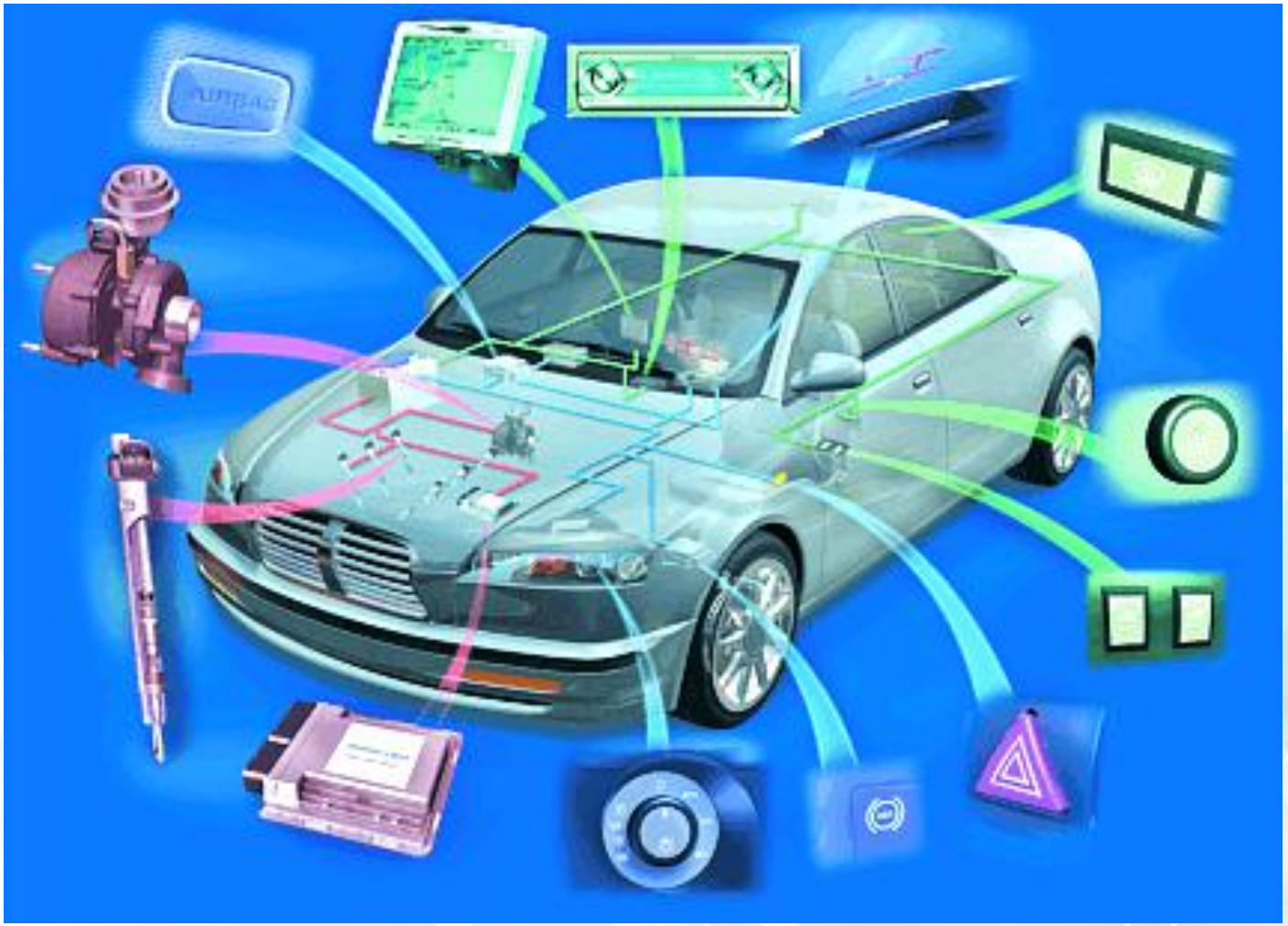
Length of Innovation Cycle

Car Platform: 10-15 years

Length of Innovation Cycle

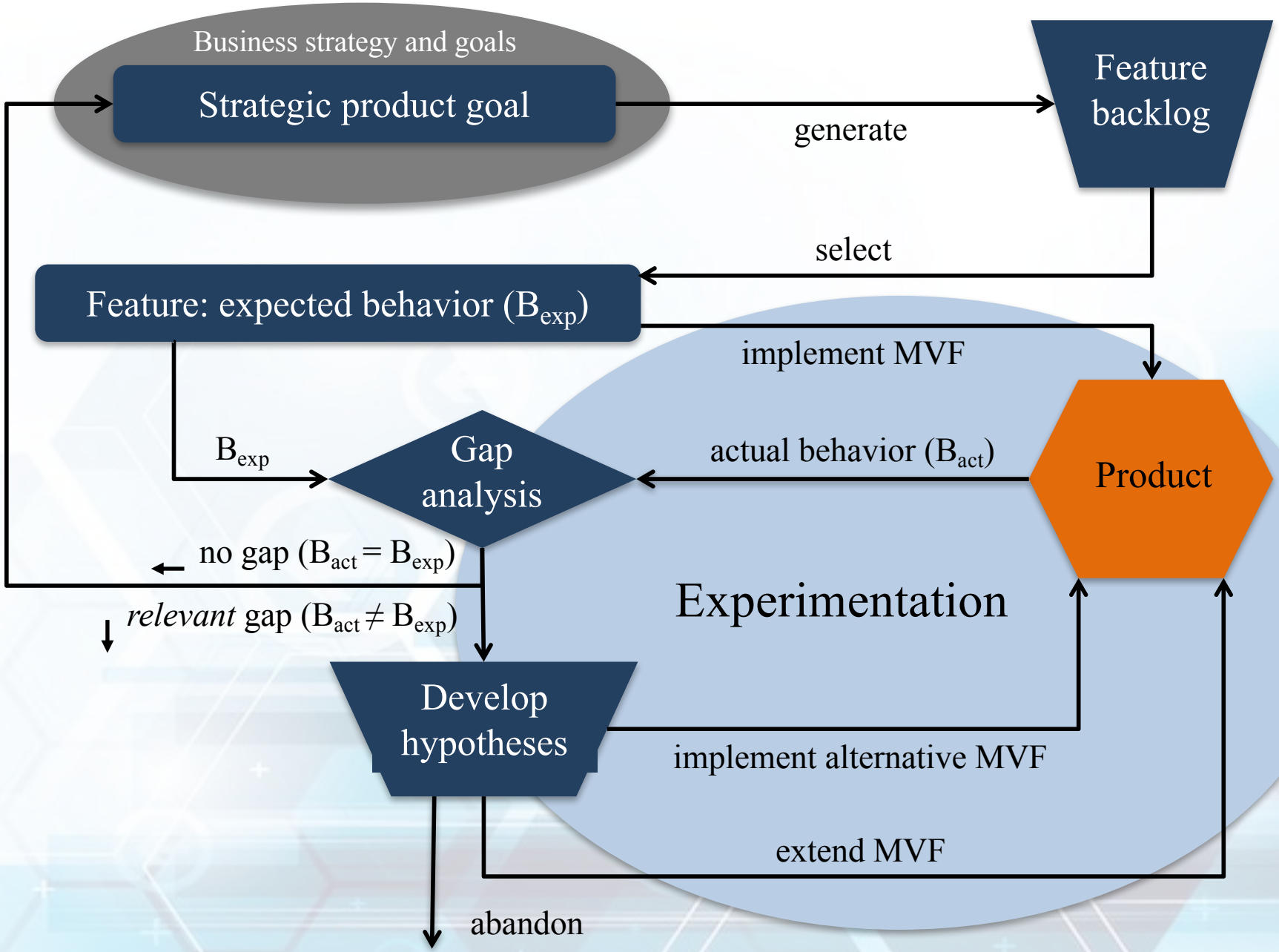
Car : 3-4 years

Length of Innovation Cycle

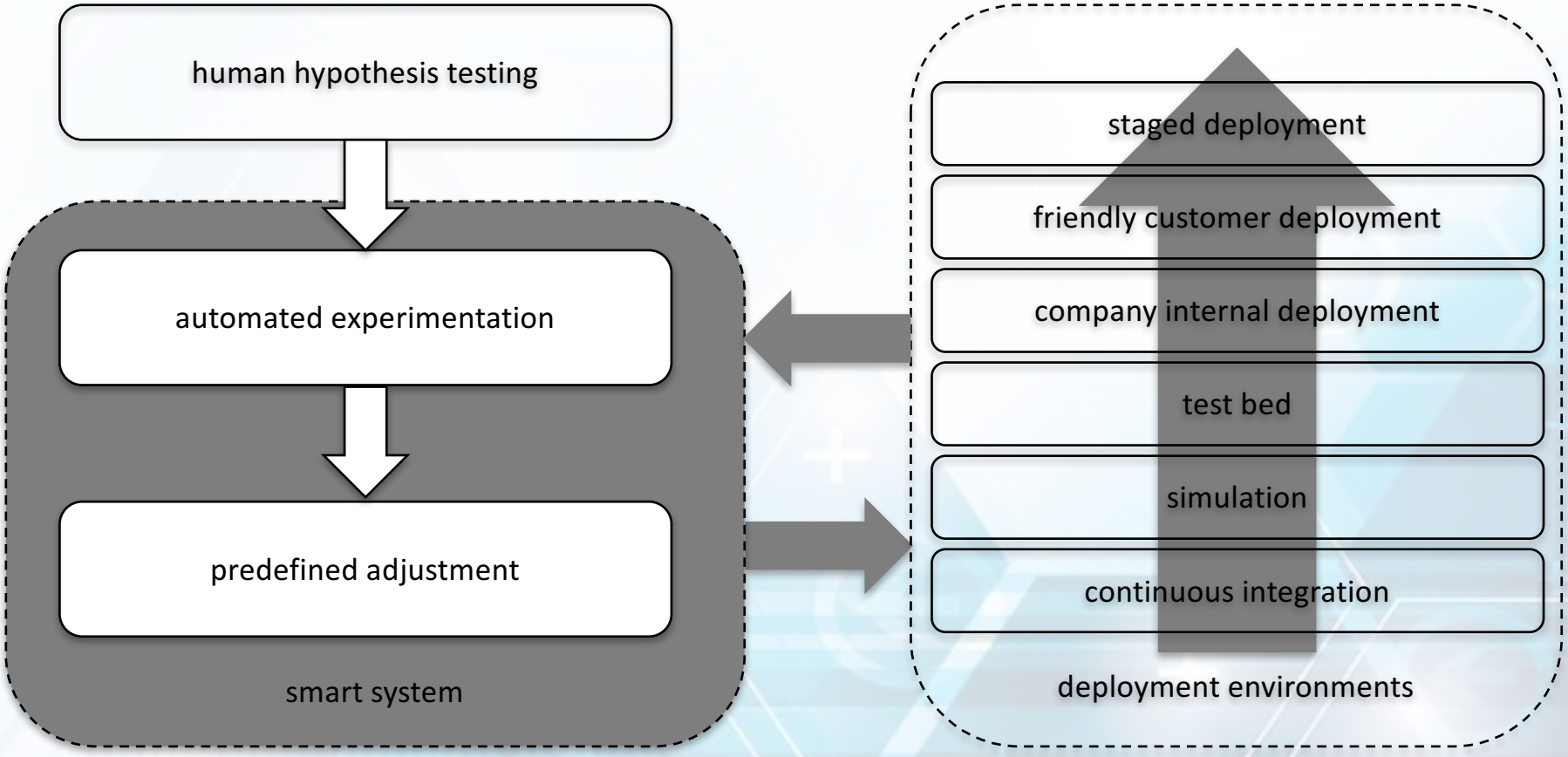


Car Software: 1-5 days

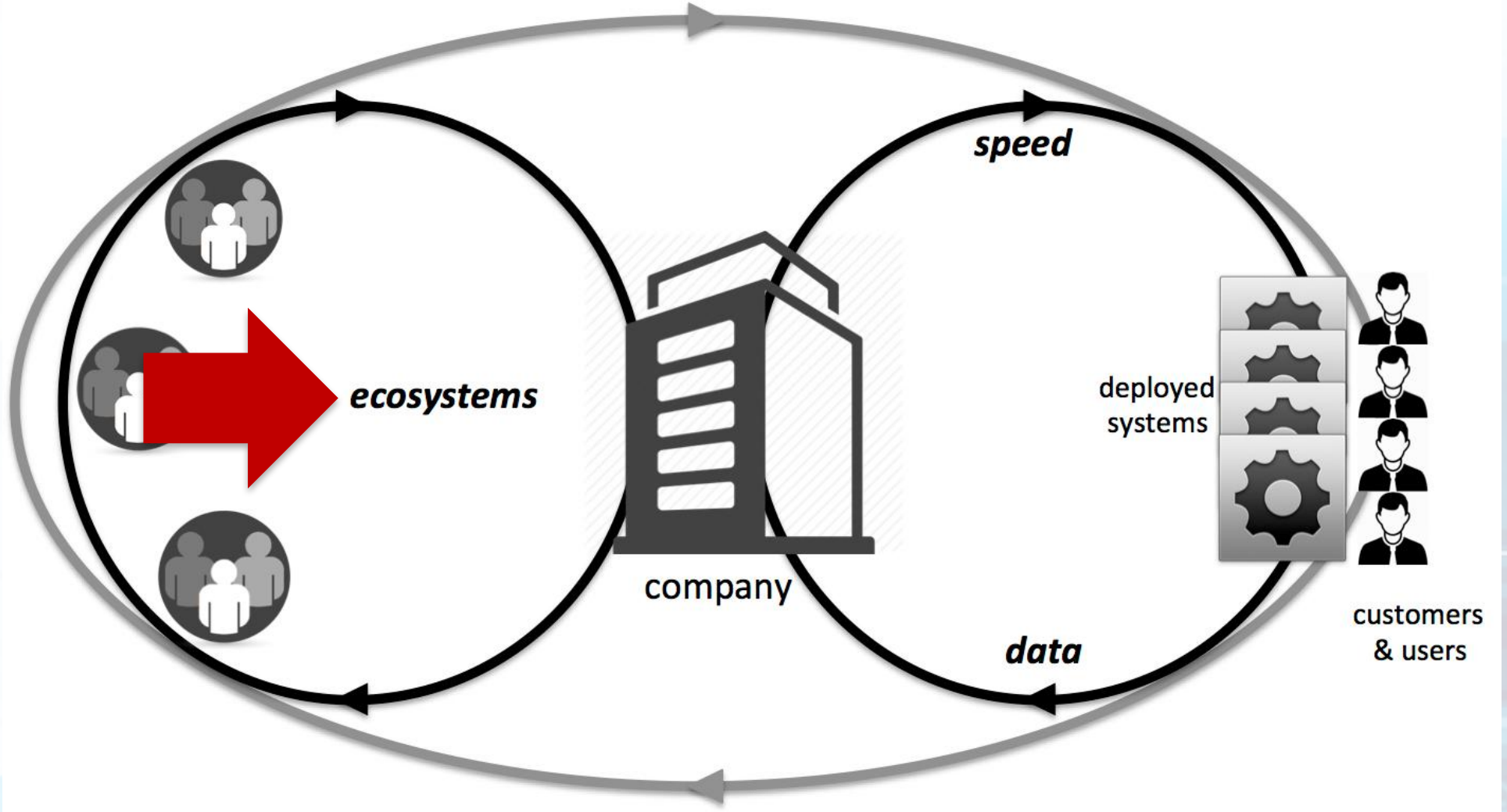
The HYPEX Model



Data-Driven Continuous Evolution of Autonomous Systems



Stairway to Heaven 2.0

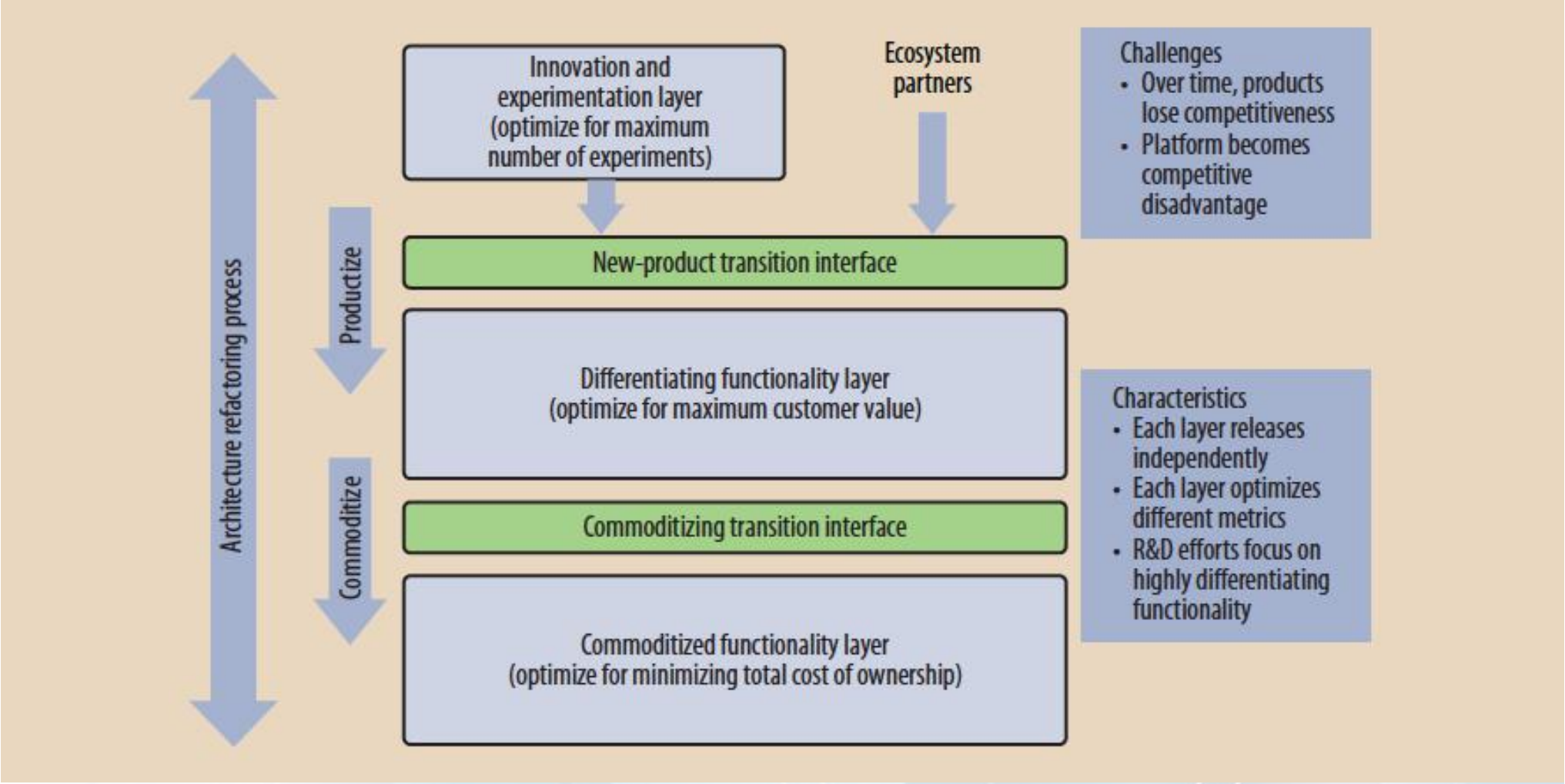


Business Ecosystem

Economic community supported by a foundation of interacting organizations and individuals, which can also be perceived as organisms of the business world (Moore, 1993).

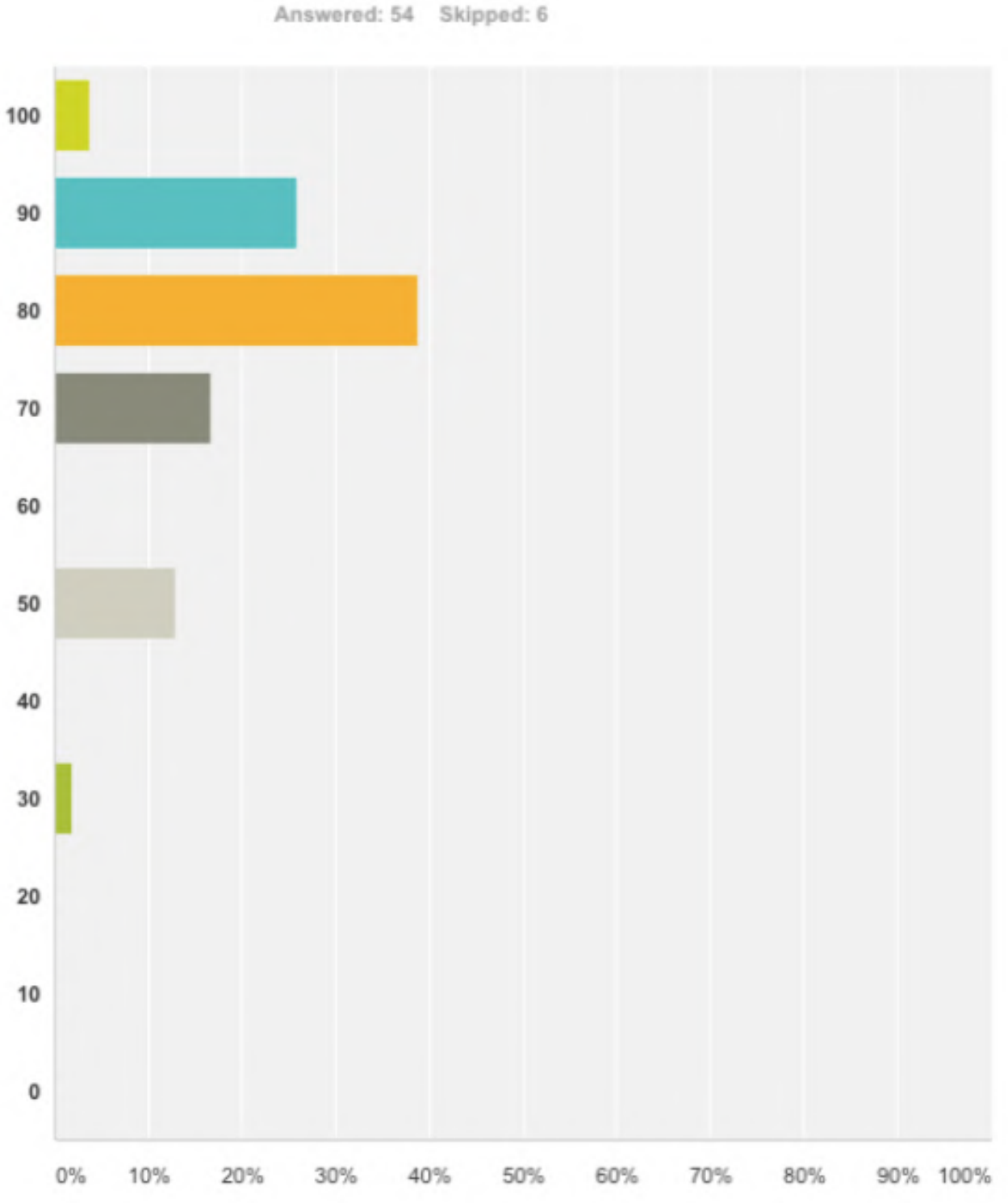
1. Symbiotic relationship
2. Co-evolution
3. Platform: tools, services and technology used in ecosystem to enhance performance

3LPM: Three Layer Product Model

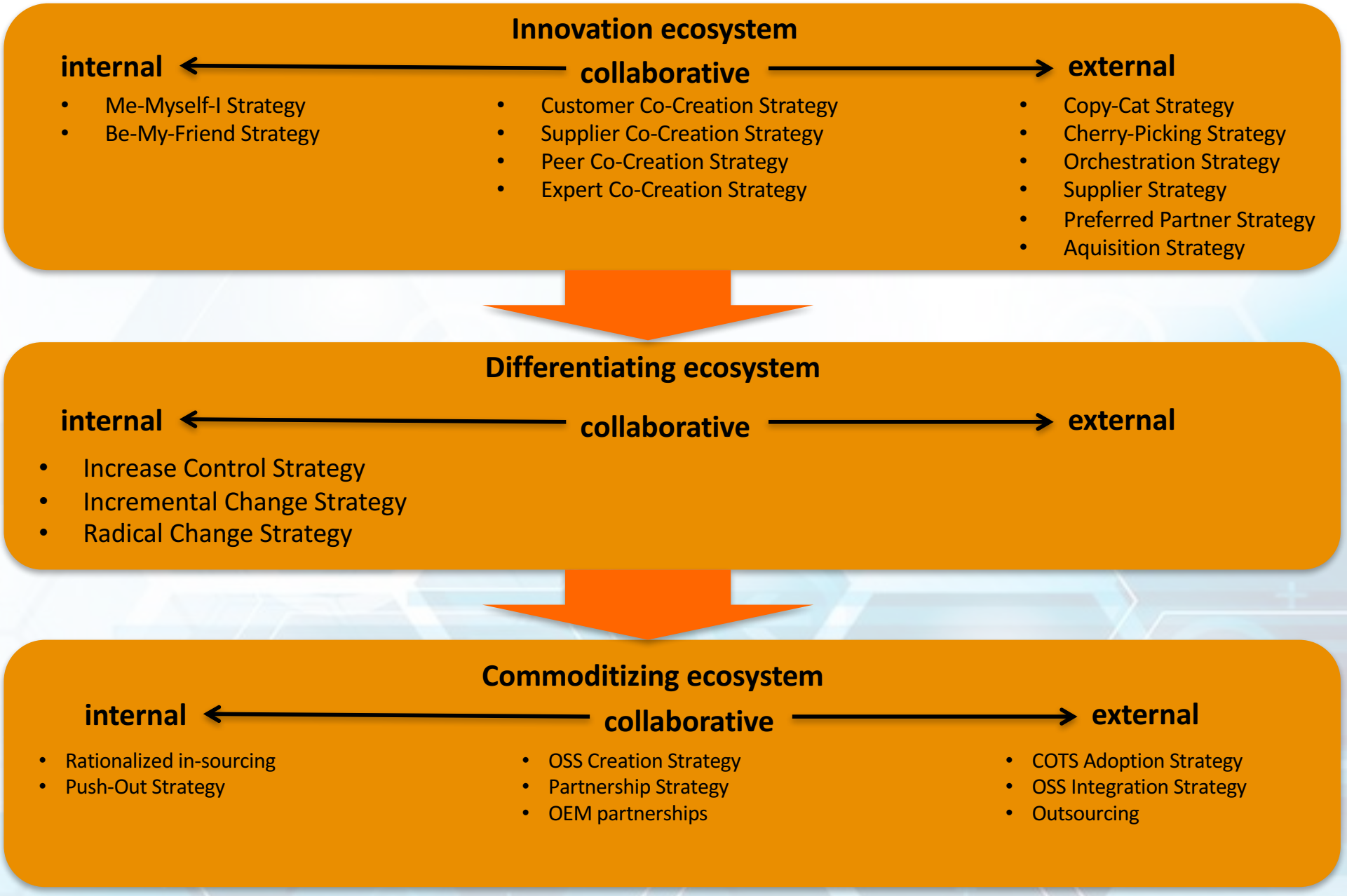


Bosch, J. (2013). Achieving Simplicity with the Three-Layer Product Model, *IEEE Computer*, Vol. 46 (11), pp. 34-39.

What % of R&D for Commodity?



TeLESM: Three Layer Ecosystem Strategy Model



Stairway to Heaven: Ecosystems

Levels	
Internally focused	do everything in-house unless it is really impossible
Ad-hoc ecosystem engagement	individuals take ad-hoc decisions to engage with ecosystem partners, but local optimization
Tactical ecosystem engagement	ecosystem engagement is centralized, but driven by tactical (rather than strategic) considerations
Strategic single ecosystem management	one of the ecosystem types is managed strategically
Strategic multi-ecosystem management	all three types (I, D, C) are managed strategically

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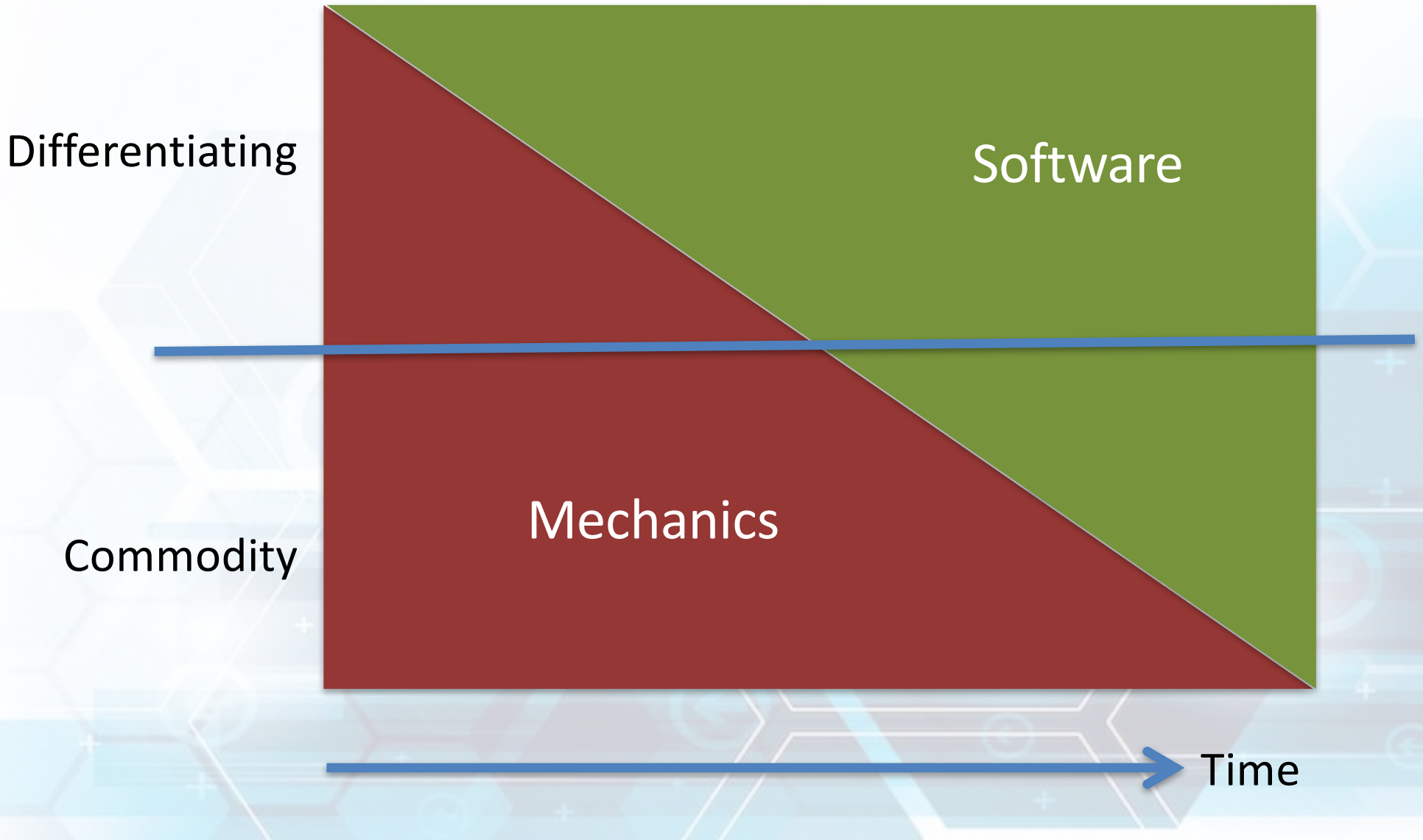
Atoms versus Bits



Implications

1. Build it in **software** unless you really, really can’t
2. Build it in **hardware** and keep it flexible (FPGAs instead of ASICS) unless you really, really can’t
3. Build it in **mechanics** if you HAVE to and keep it modular, easily replaceable and simple

Implications

From	To
• Systems built to last	• Systems built to evolve
• Opinions-based decision making (experience)	• Data-driven decision making
• Deeply integrated architectures	• Modularized architectures
• Hierarchical organizational model	• Ecosystem of partners
• Satisfying the requirements	• Constant experimentation and innovation
• Static certification	• Dynamic, continuous certification

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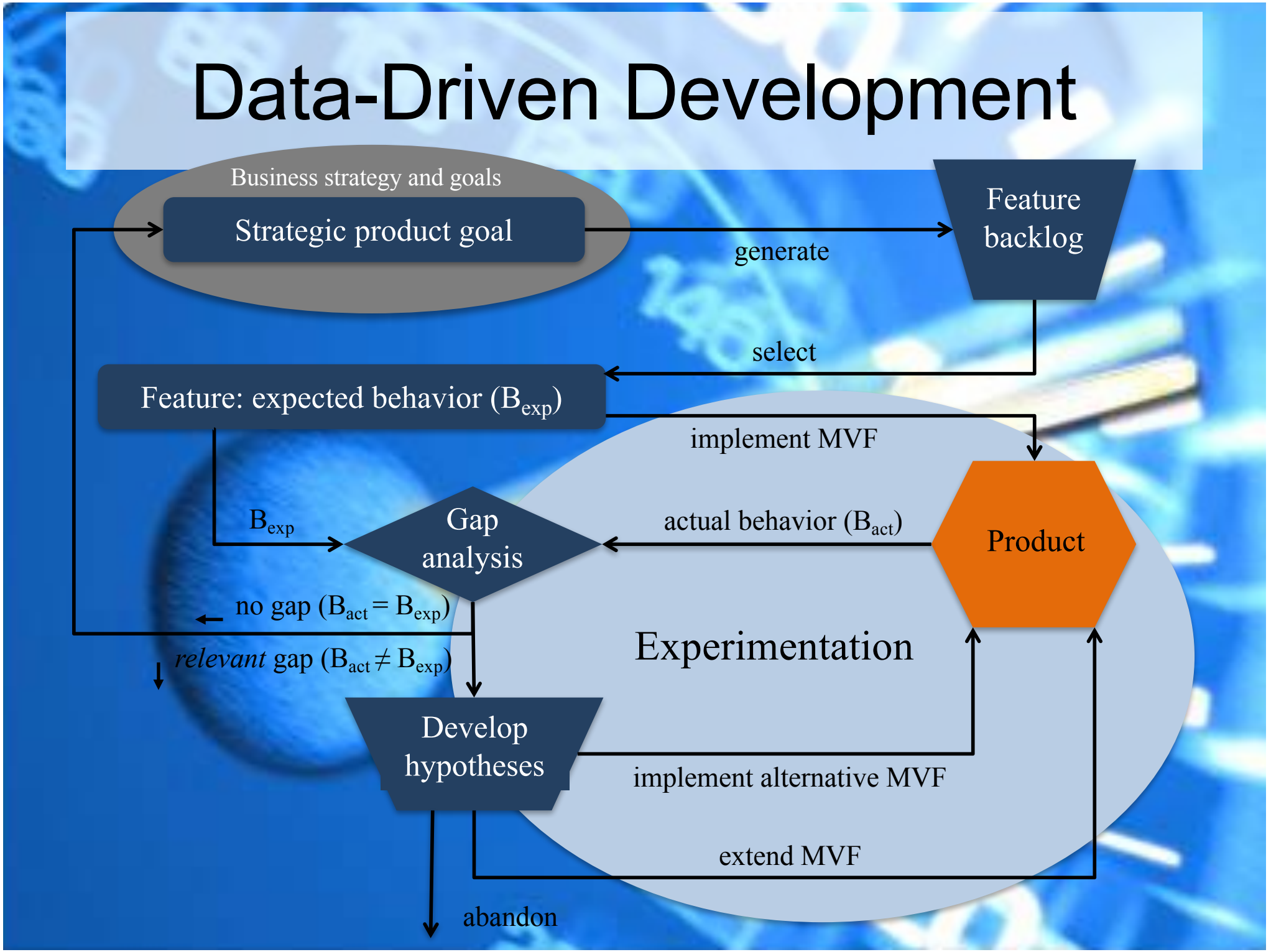
“In the future, all companies will be software companies”
George F. Colony (CEO Forrester Research)

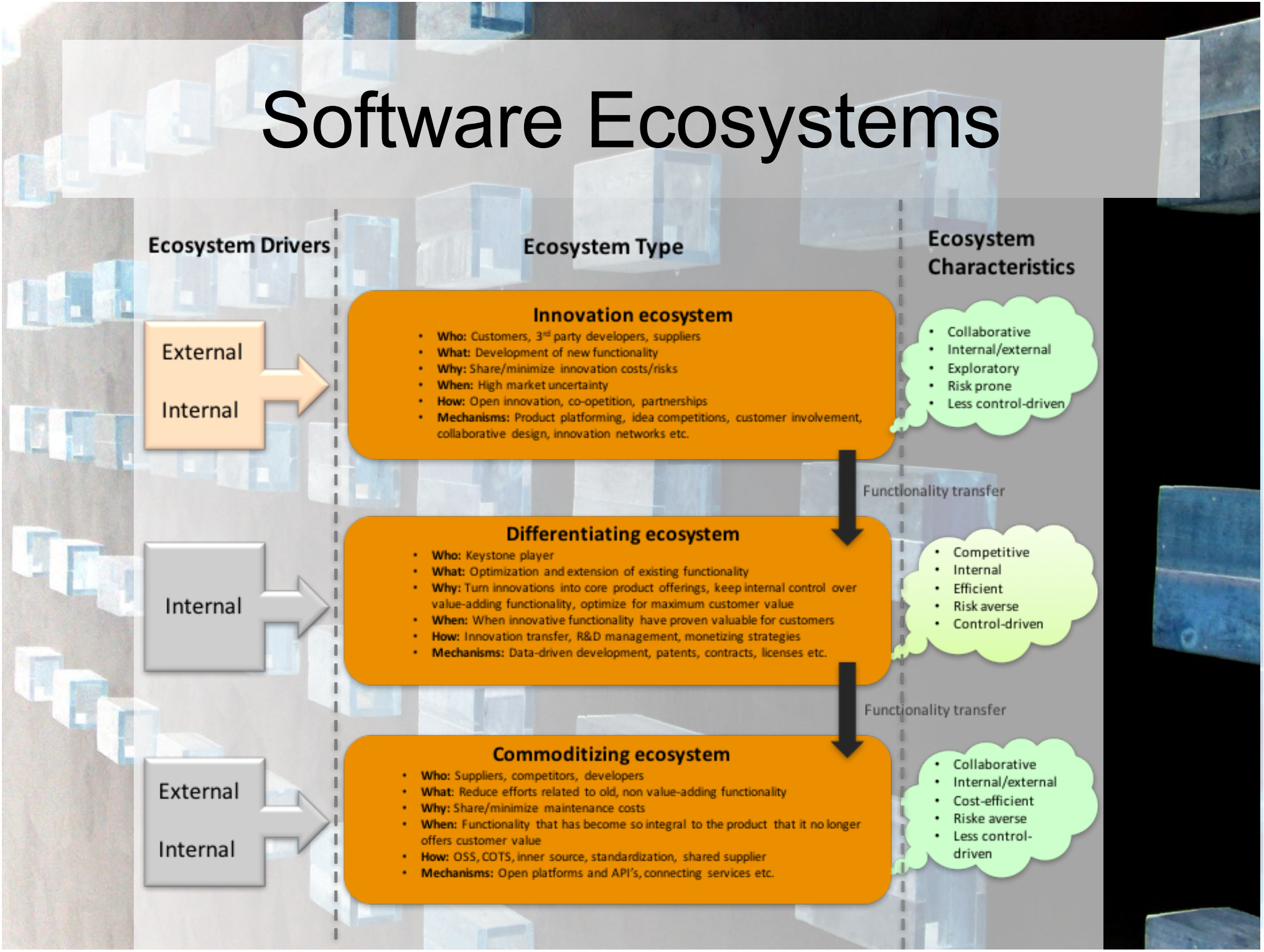
Speed

- Increasing **SPEED** trumps ANY other improvement R&D can provide to the company – the goal is **continuous deployment** of new functionality
- If you're not a front-line engineer, there is only ONE measure that justifies your existence: how have you helped teams move faster?
- Don't optimize efficiency, optimize speed

Data-Driven Development



Software Ecosystems



Not My Job?!

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