WELCOME

SERC TALKS

Speed, Data and Ecosystems: How to Excel in a Software-Driven World?

Jan Bosch, Professor of Software Engineering, Director Software Center, Chalmers University of Technology

February 7 | 11:00 AM ET

❑ Today's session will be recorded.

❑ An archive of today's talk will be available at: www.sercuarc.org/serc-talks/

❑ Use the Q&A box to queue questions, reserving the chat box for comments, and questions will be answered during the last 5-10 minutes of the session.

❑ If you are connected via the dial-in information only, please email questions or comments to Ms. Mimi Marcus at mmarcus@stevens.edu.

❑ Any issues? Use the chat feature for any technical difficulties or other comments, or email Ms. Mimi Marcus at mmarcus@stevens.edu.

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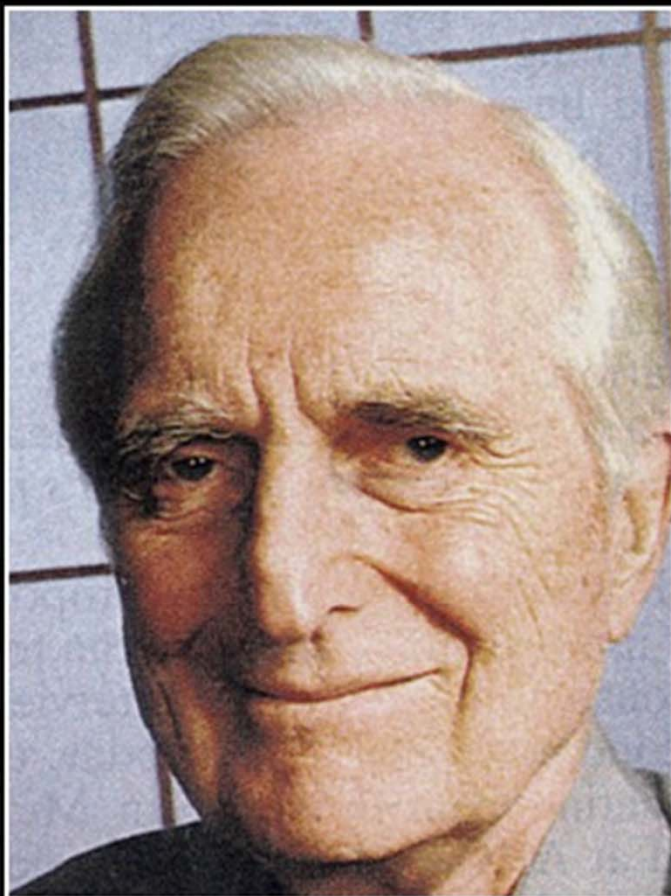
Speed, Data and Ecosystems:
How to Excel in a Software-Driven World?

Jan Bosch

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SERC Talk, February 2018

Fortune 500

52% of the Fortune 500 firms since 2000 are gone

Disruption Is The New Normal

- Jim Collins (Built to last): Companies last, on average, ~~30~~ **~~15~~ 10** years on the Fortune 500 list. And that time period is decreasing

- Main cause: Companies fail to innovate and to build new core capabilities

Digitalization Is The New Disruptor!
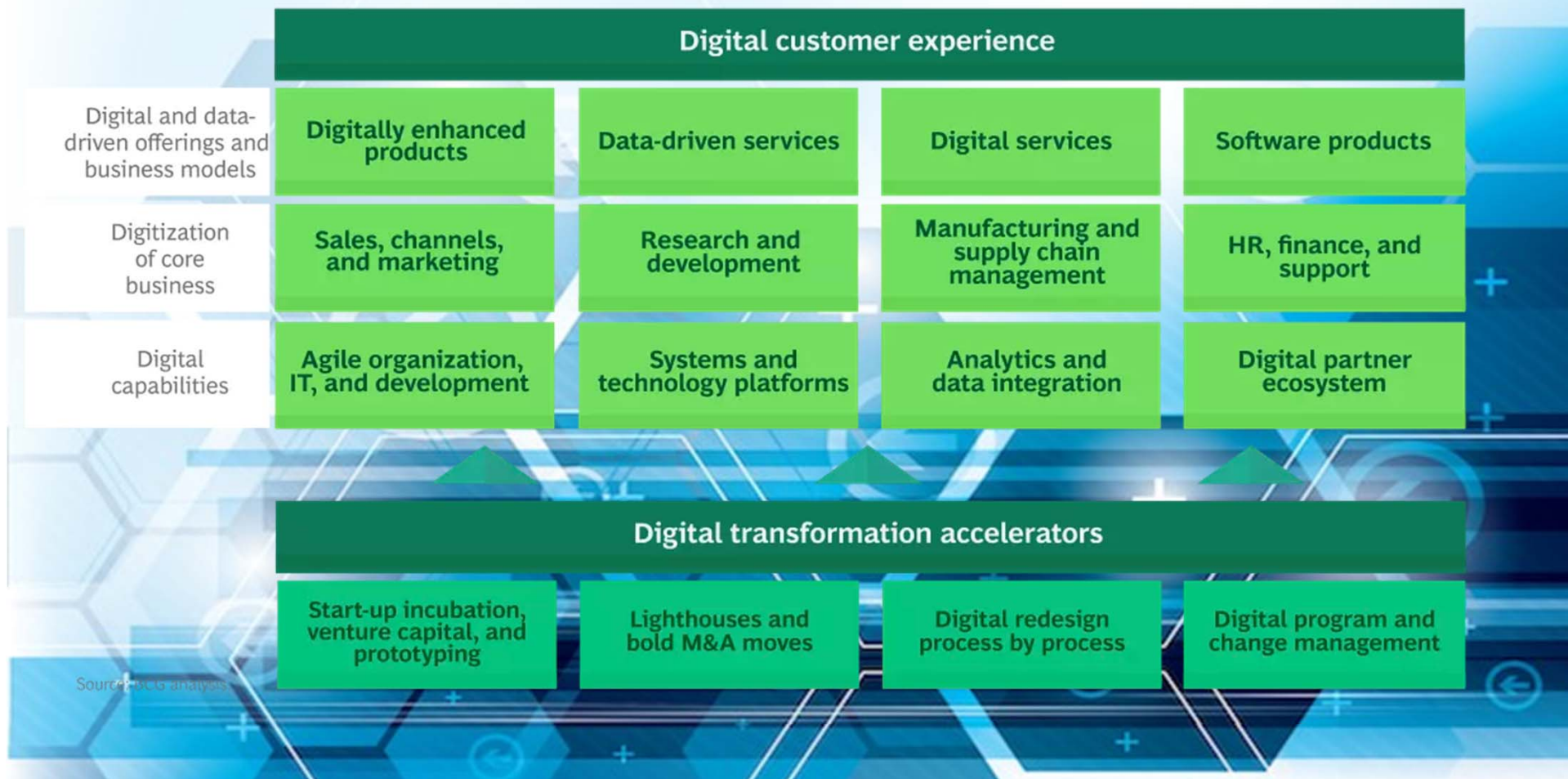
Digitalization

Digitalization is the use of digital technologies to change a **business model** and provide **new revenue** and **value-producing opportunities**; it is the process of moving to a **digital business**.
- Gartner

Digitalization

The Strategic Building Blocks of Digital Transformation

Digital customer experience			
Digital and data-driven offerings and business models	Digitally enhanced products	Data-driven services	Digital services	Software products
Digitization of core business	Sales, channels, and marketing	Research and development	Manufacturing and supply chain management	HR, finance, and support
Digital capabilities	Agile organization, IT, and development	Systems and technology platforms	Analytics and data integration	Digital partner ecosystem

Digital transformation accelerators			
Start-up incubation, venture capital, and prototyping	Lighthouses and bold M&A moves	Digital redesign process by process	Digital program and change management

Source: BCG analysis

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 as well as the **ECOSYSTEMS** around your systems and services in the field are the next areas to exploit and monetize

- We are moving towards a new business operating mechanism focused on **EMPOWERMENT** and **autonomy**
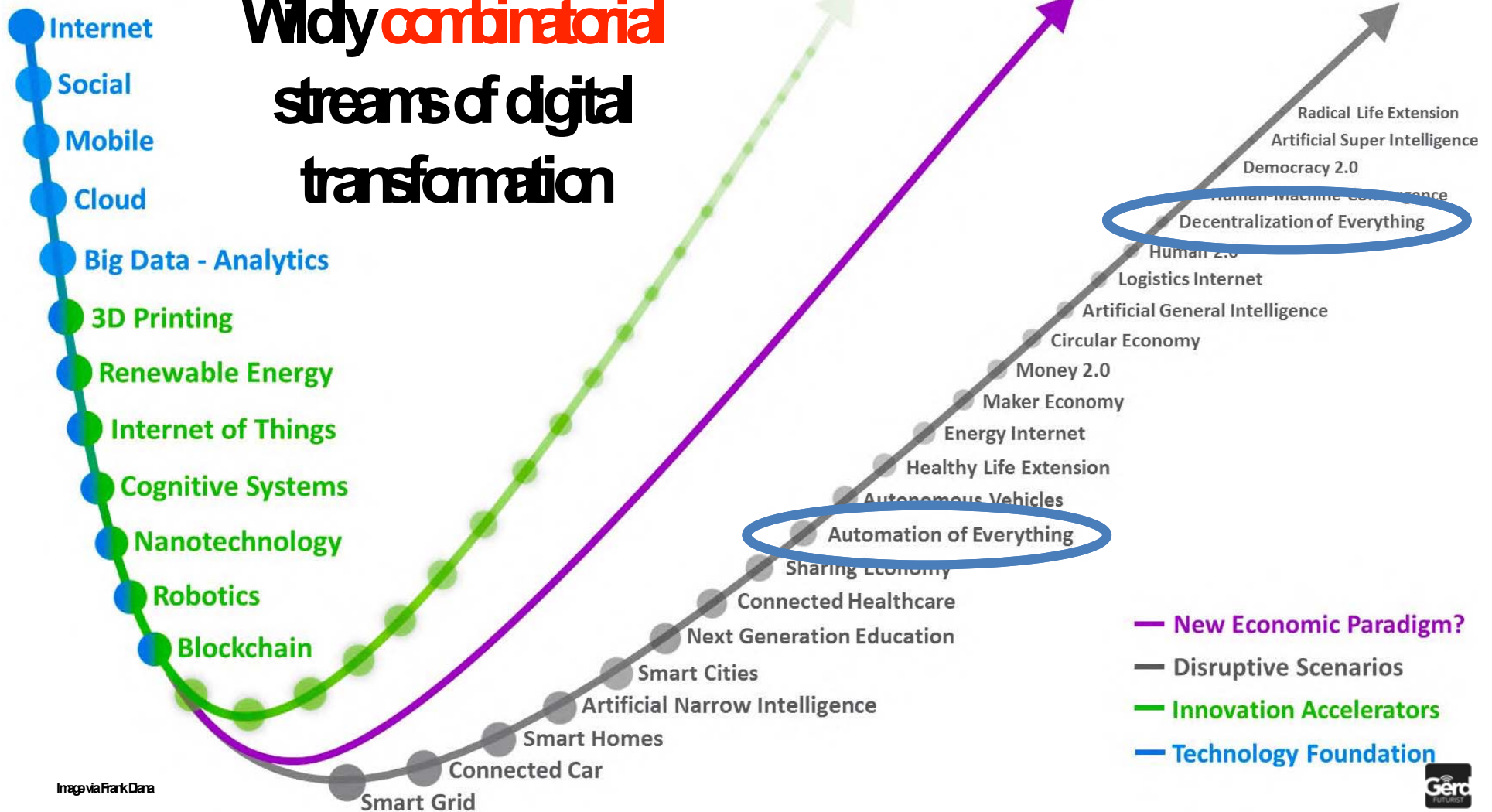
Overview

- Vem är jag? Wie ben ik? Who am I?
- Trends in Industry: Need for Speed
- Towards a New Business Operating System
  – Speed
  – Data
  – Ecosystems
  – Empowerment
- Conclusion

Academic Research

Software Center

Software Center

Consultancy

ERICSSON

BOSCH

SIEMENS

BASF
The Chemical Company

GRUNDFOS

SONY
make.believe

JEPPESEN

THALES

VARIAN
medical systems

AirTies
wireless networks

transmode

SEB

Startups

fidesmo

Remente

Burt.

AuQtus
Automated Quality Testing of User Scenarios

Industry Innovation

intuit

NOKIA

PELTARION

ASSIA

Industry Operations

NOKIA

Software Center

Mission: Improve the *digitalization* capability of the European Software-Intensive industry with an order of magnitude

Theme: Fast, continuous deployment of customer value

Success: Academic excellence

Success: Industrial impact

Research Themes

Application Domain Themes

Shared public/partner funding

Autonomous Systems

WASP

Internet of Things

IOTAP

System of Systems

Predominantly partner funding

Continuous Delivery

Continuous Architecture

Metrics

Customer Data and Ecosystems

Technology Themes

Some Online Companies

BOOKING.COM
online hotel reservations

Spotify®

ROVIO

Klarna
Simplifying Buying

King

Microsoft

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Gartner 2017 Technology Hype Cycle

expectations

Connected Home
Deep Learning
Machine Learning
Virtual Assistants
IoT Platform
Autonomous Vehicles
Nanotube Electronics
Smart Robots
Edge Computing
Cognitive Computing
Augmented Data Discovery
Blockchain
Smart Workspace
Commercial UAVs (Drones)
Conversational User Interfaces
Cognitive Expert Advisors
Brain-Computer Interface
Volumetric Displays
Quantum Computing
Digital Twin
Serverless PaaS
5G
Human Augmentation
Neuromorphic Hardware
Deep Reinforcement Learning
Enterprise Taxonomy and Ontology Management
Software-Defined Security
Virtual Reality
Artificial General Intelligence
4D Printing
Augmented Reality
Smart Dust

As of July 2017

Innovation Trigger | Peak of Inflated Expectations | Trough of Disillusionment | Slope of Enlightenment | Plateau of Productivity

time

Years to mainstream adoption:
○ less than 2 years   ○ 2 to 5 years   ● 5 to 10 years   △ more than 10 years   ⊗ obsolete before plateau

Note: PaaS = platform as a service; UAVs = unmanned aerial vehicles

Wildly **combinatorial** streams of digital transformation

Technology Foundation:
- Internet
- Social
- Mobile
- Cloud
- Big Data - Analytics

Innovation Accelerators:
- 3D Printing
- Renewable Energy
- Internet of Things
- Cognitive Systems
- Nanotechnology
- Robotics
- Blockchain

Disruptive Scenarios:
- Smart Grid
- Connected Car
- Smart Homes
- Artificial Narrow Intelligence
- Smart Cities
- Next Generation Education
- Connected Healthcare
- Sharing Economy
- Automation of Everything
- Autonomous Vehicles
- Healthy Life Extension
- Energy Internet
- Maker Economy
- Money 2.0
- Circular Economy
- Artificial General Intelligence
- Logistics Internet
- Human 2.0
- Decentralization of Everything
- Human-Machine Convergence
- Democracy 2.0
- Artificial Super Intelligence
- Radical Life Extension

Legend:
— New Economic Paradigm?
— Disruptive Scenarios
— Innovation Accelerators
— Technology Foundation

Image via Frank Diana

INTELLIGENCE

"We want Google to be the third half of your brain."
Sergey Brin

Automation

Deep Learning

Software Drives Everything

Self-Driving Cars
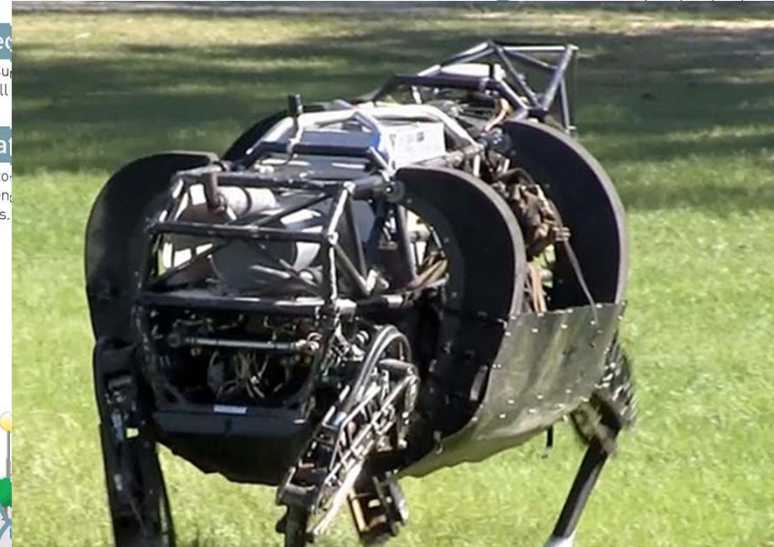
Robots

Gripen Drone

3D Cement Printing

The Cycle of Innovation
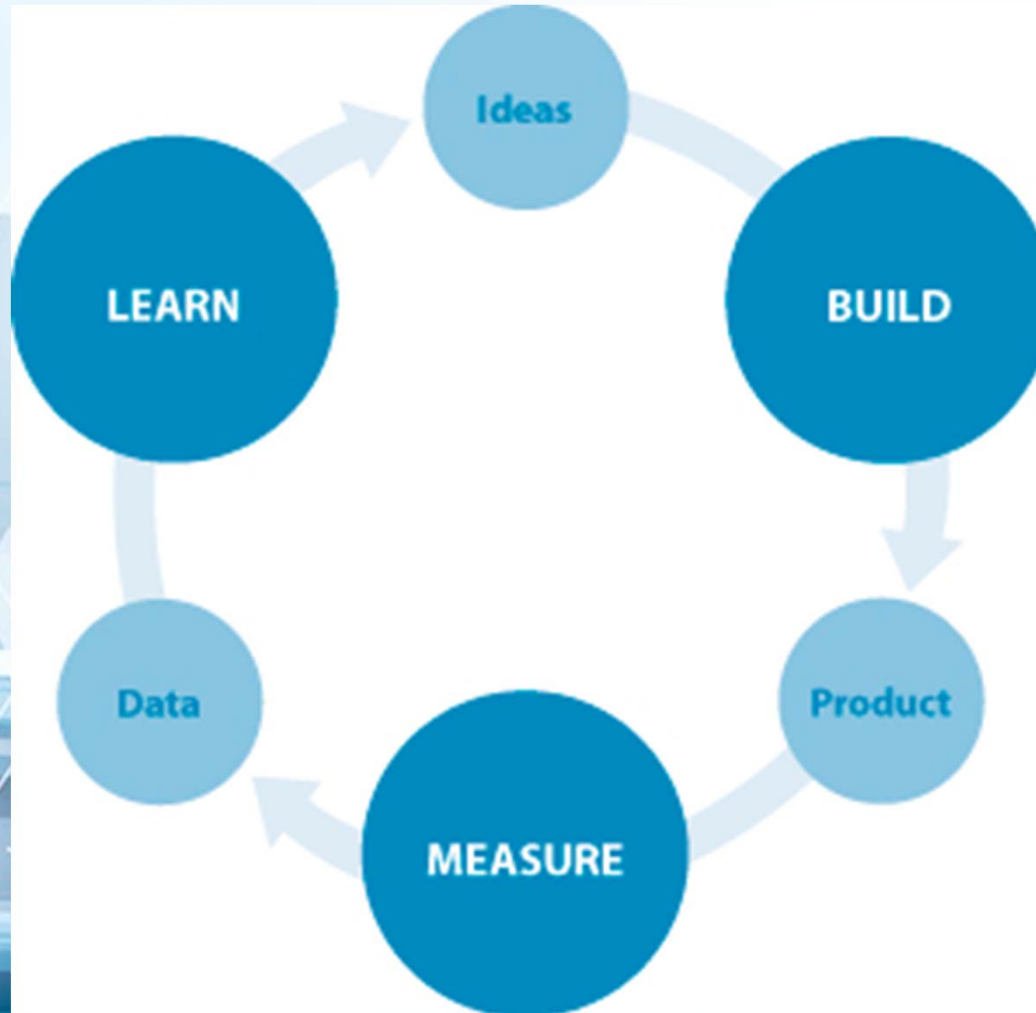
Length of Innovation Cycle

Car Platform: 10-15 years

Length of Innovation Cycle

Car: 3-4 years

Length of Innovation Cycle

Car Software: 1-5 days
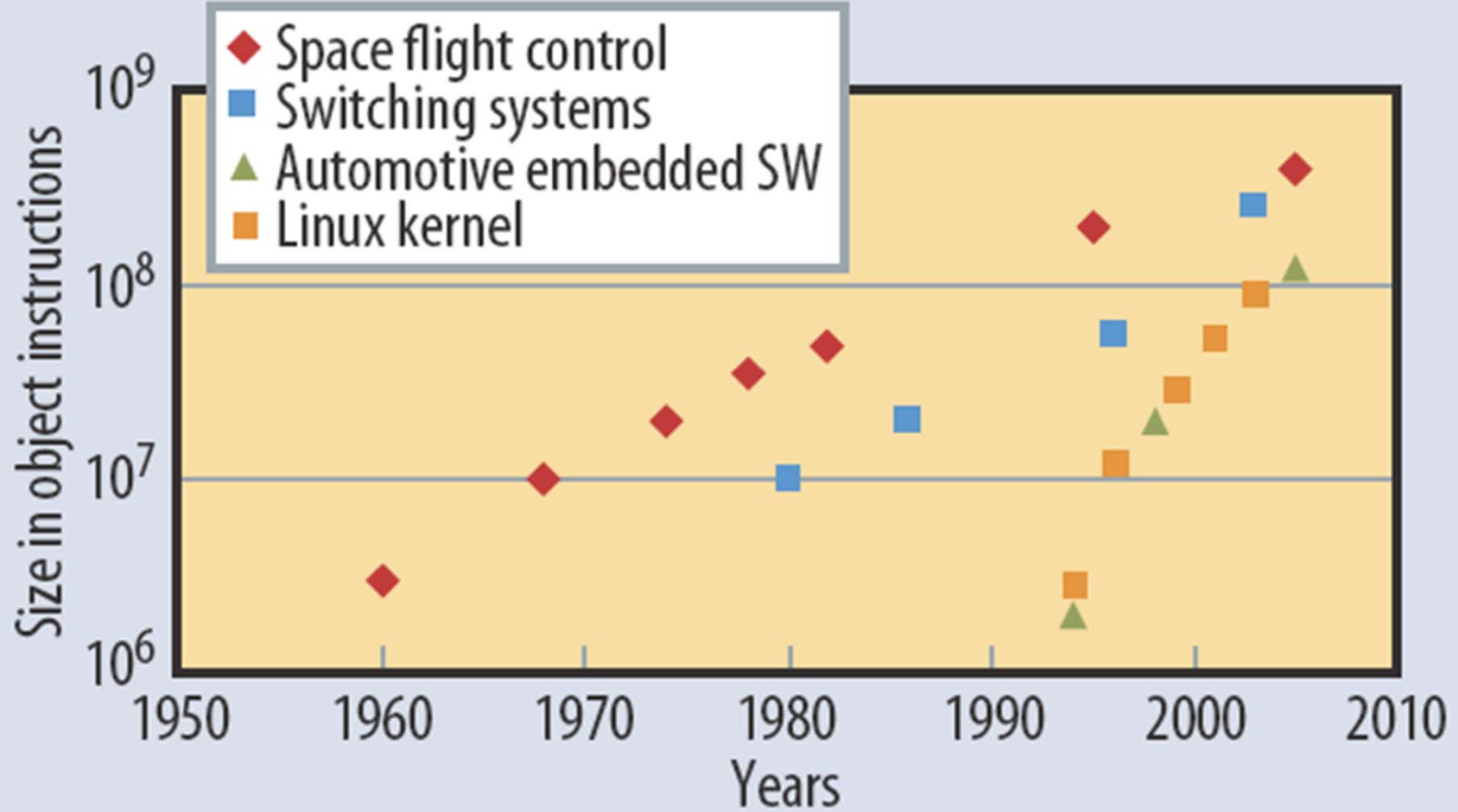
10x every ~7 years

Volvo XC 90
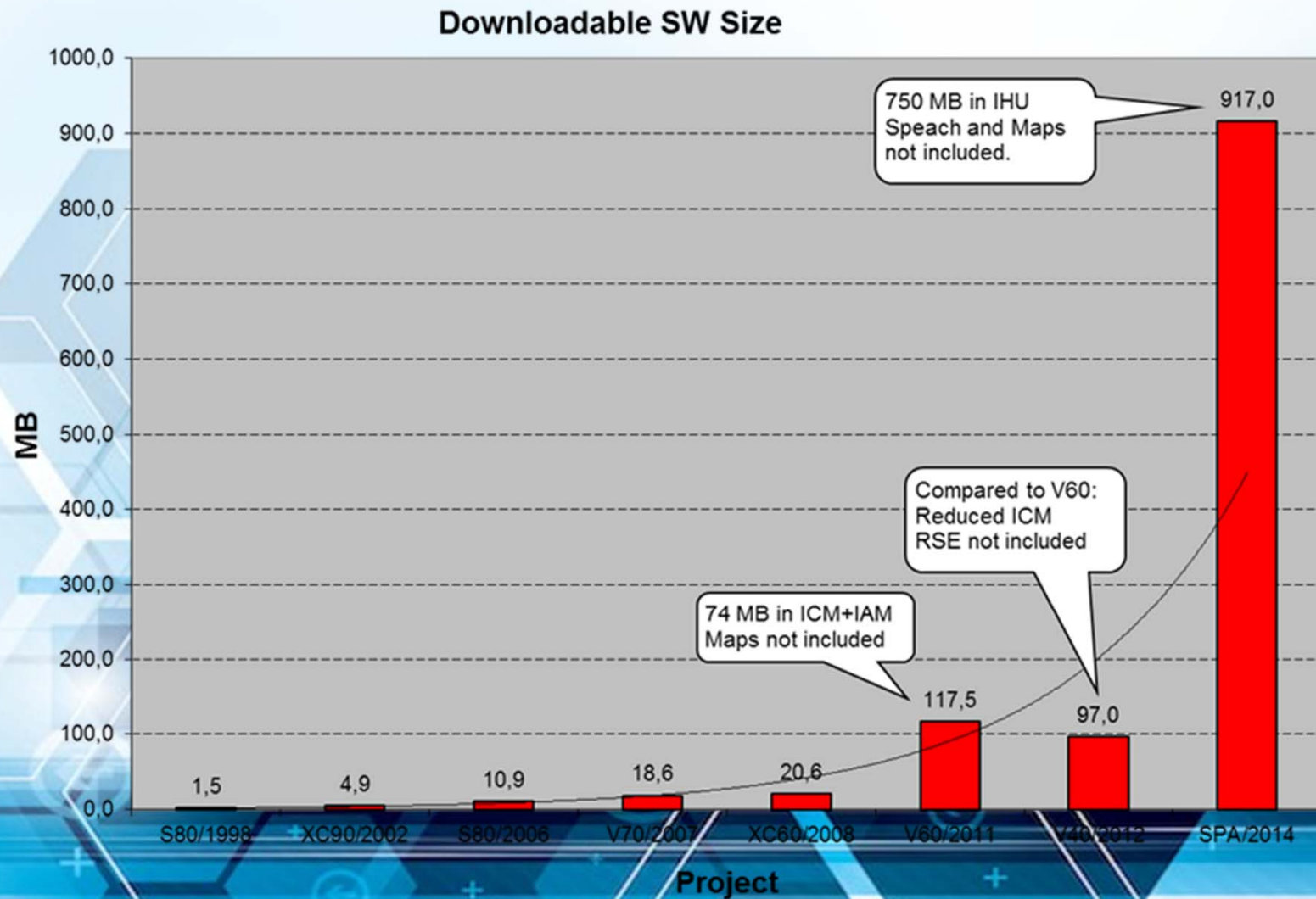
Data Generated in the World
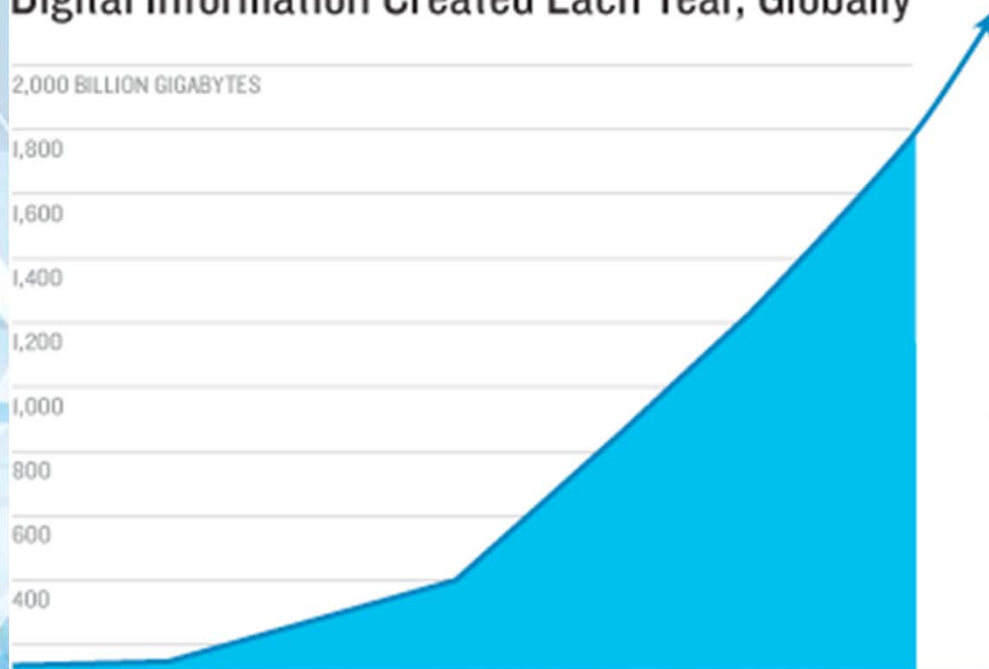
50 Terabytes of data are created every second

EVERY · MINUTE · OF · THE · DAY

PINTEREST USERS PIN 3,472 images.

YOUTUBE USERS UPLOAD 72 HRS. OF NEW VIDEO.

EMAIL USERS SEND 204,000,000 MESSAGES.

Google RECEIVES OVER 4,000,000 SEARCH QUERIES.

VINE USERS SHARE 8,333 VIDEOS.

FACEBOOK USERS SHARE 2,460,000 PIECES OF CONTENT.

SKYPE USERS CONNECT FOR 23,300 HOURS.

TINDER USERS SWIPE 416,667 TIMES.

YELP USERS POST 26,380 REVIEWS.

WHATSAPP — USERS SHARE — 347,222 PHOTOS.

APPLE USERS DOWNLOAD 48,000 apps.

PANDORA USERS LISTEN TO 61,141 HOURS OF music.

AMAZON MAKES $83,000 IN ONLINE SALES.

INSTAGRAM USERS » POST 216,000 NEW PHOTOS.

TWITTER USERS TWEET 277,000 TIMES.

THE GLOBAL INTERNET POPULATION GREW 14.3% FROM 2011 - 2013 AND NOW REPRESENTS 2.4 BILLION PEOPLE.

Trend: Need for Speed

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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  - Empowerment
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3LPM: Three Layer Product Model
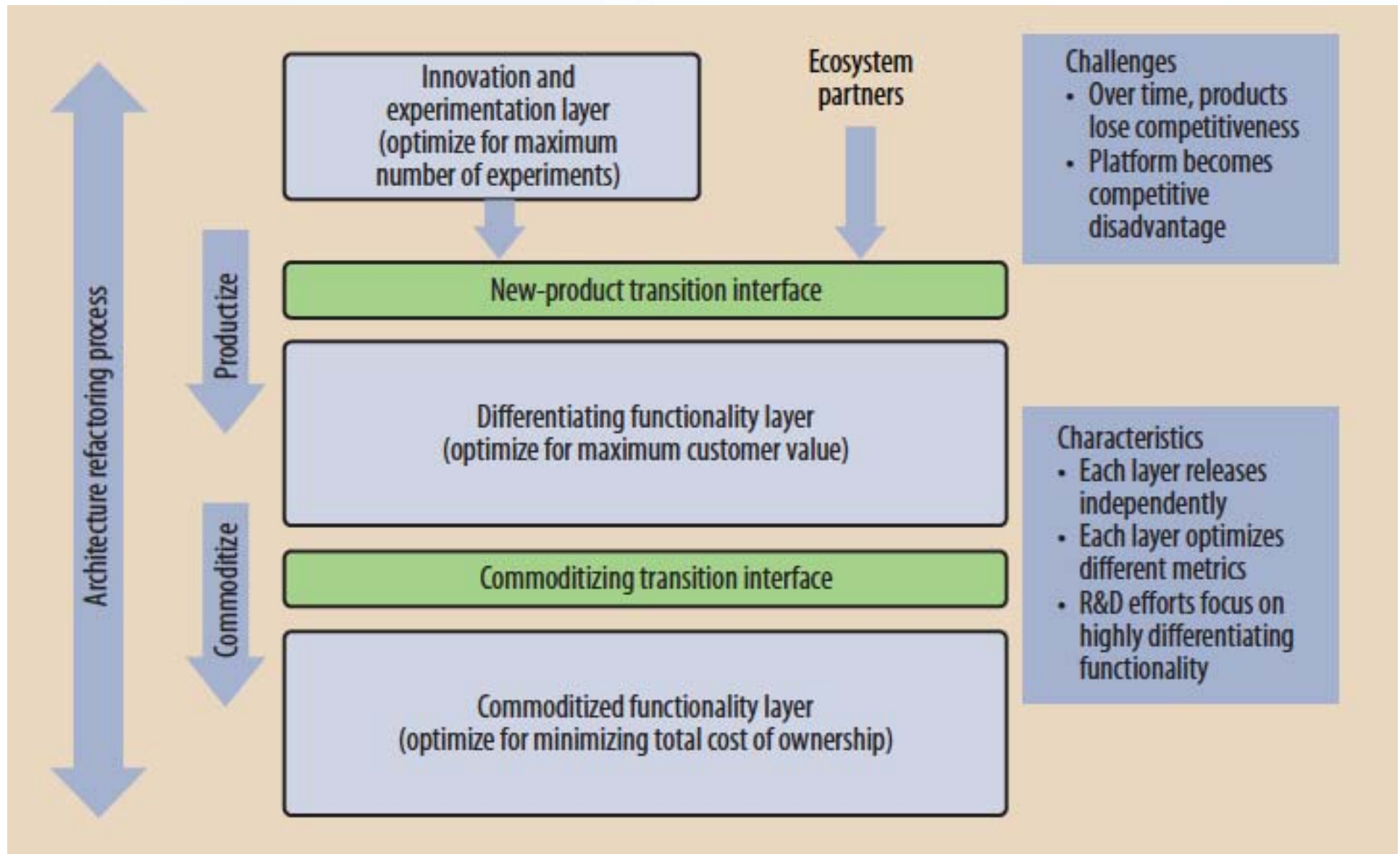
How do I organize for operating in this model?

Stage	Question	Focus
innovation	• How do I expand my innovation funnel?	ecosystem
transition	• How do I deliver innovations to market faster?	speed
differen-tiation	• How do I know that what I'm building provides value to customers?	data
transition	• How do I identify commoditization of functionality?	data
commodity	• How do I minimize total cost of ownership for commodity functionality?	ecosystem

empowerment

A New Business Operating System

- Business agility

- Instrument and measure

speed | data

empowerment | ecosystem

- Empower teams

- Focus on differentiation

Stairway to Heaven: Speed

Traditional Development	R&D Organization All Agile	Continuous Integration	Continuous Deployment	R&D as an Innovation System
				Sales & mrkt
				Prod. mgmt.
			Cust. Sup.	Cust. sup.
			Release	Release
		V&V	V&V	V&V
	R&D teams	R&D teams	R&D teams	R&D teams
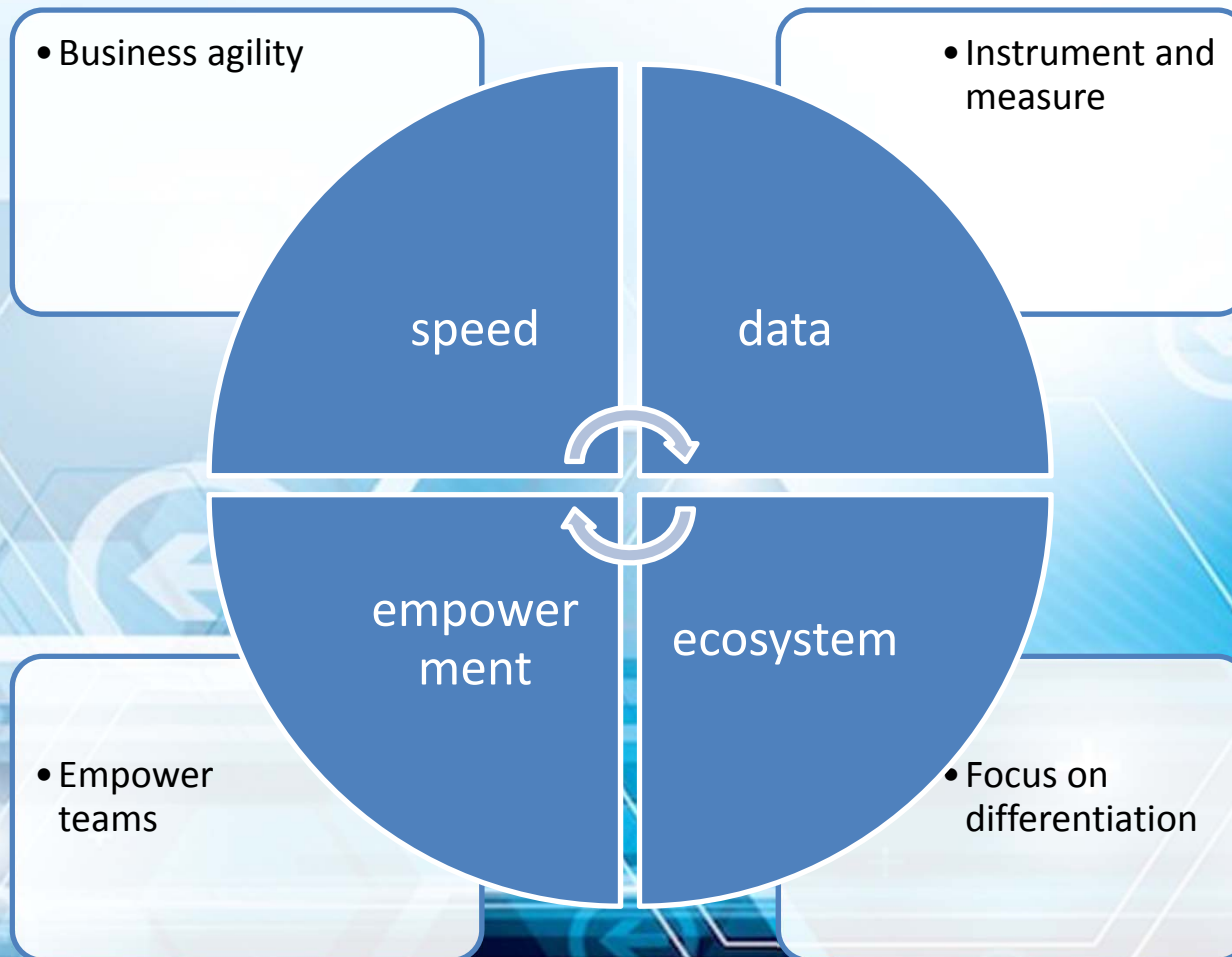
Feedback Cycles

- Development cycle
- Requirements cycle
- Quality assurance cycle
- Governance cycle
- Deployment cycle
- Value creation cycle

Feedback Cycles and Speed

	Traditional	Agile	CI	CD	Inno System
Development	Long	Sprint	Sprint	Sprint	Sprint
Requirements	Long	Sprint	Sprint	Sprint	Sprint
Quality assurance	Long	Long	Sprint (internal)	Sprint (external)	Sprint (external)
Governance	Long	Long	Sprint	Sprint	Sprint
Deployment	Long	Long	Long	Sprint	Sprint
Value creation	Long	Long	Long	Long	Sprint

Slow: opinion-based; sprint: data-driven

CAUSES	CLASSES OF ATD	PHENOMENA (EFFECTS)	EXTRA-ACTIVITIES

Debt — CLASSES OF ATD

Interest — PHENOMENA (EFFECTS), EXTRA-ACTIVITIES

* Cause of ATD generation

Causes

Classes of ATD:
- Duplication - reuse
- Dependencies Unawareness
- Non identified non-functional requirements
- Temporal properties - behavior
- Non uniformity - Policies

Phenomena (Effects):
- "Double" effort
- Repeated wrapping
- Contagious ATD
- Big deliveries involving many developers
- Quality issues
- Hidden ATD
- Non-completed refactoring
- Time pressure
- Wrong estimation of effort
- Confusion
- Lack of familiarity and experience

Extra-activities:
- Duplicated activities
- New code
- Adaptation of existing code
- Testing
- Bug Fixing
- Finding hidden problems
- Understanding

Martini, A., Bosch, J., Chaudron, M., 2014. *"Architecture Technical Debt: Understanding Causes and a Qualitative Model"*, Best Paper Award at 40th Euromicro Conference on Software Engineering and Advanced Applications.

Visualizing Continuous Integration And Test
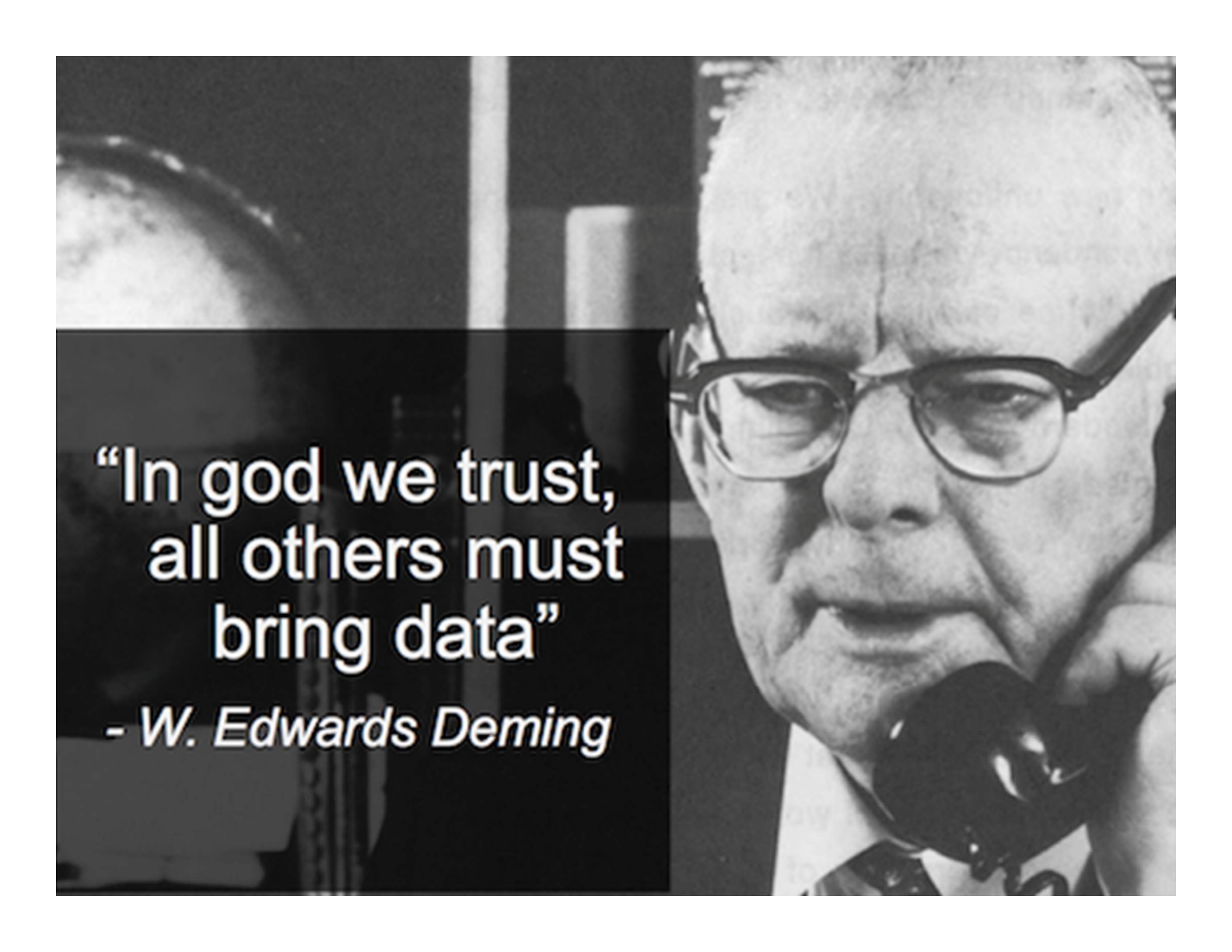
Continuous Delivery Model

Stairway to Heaven: Data

Ad-Hoc

Collection

Automation

Data innovation

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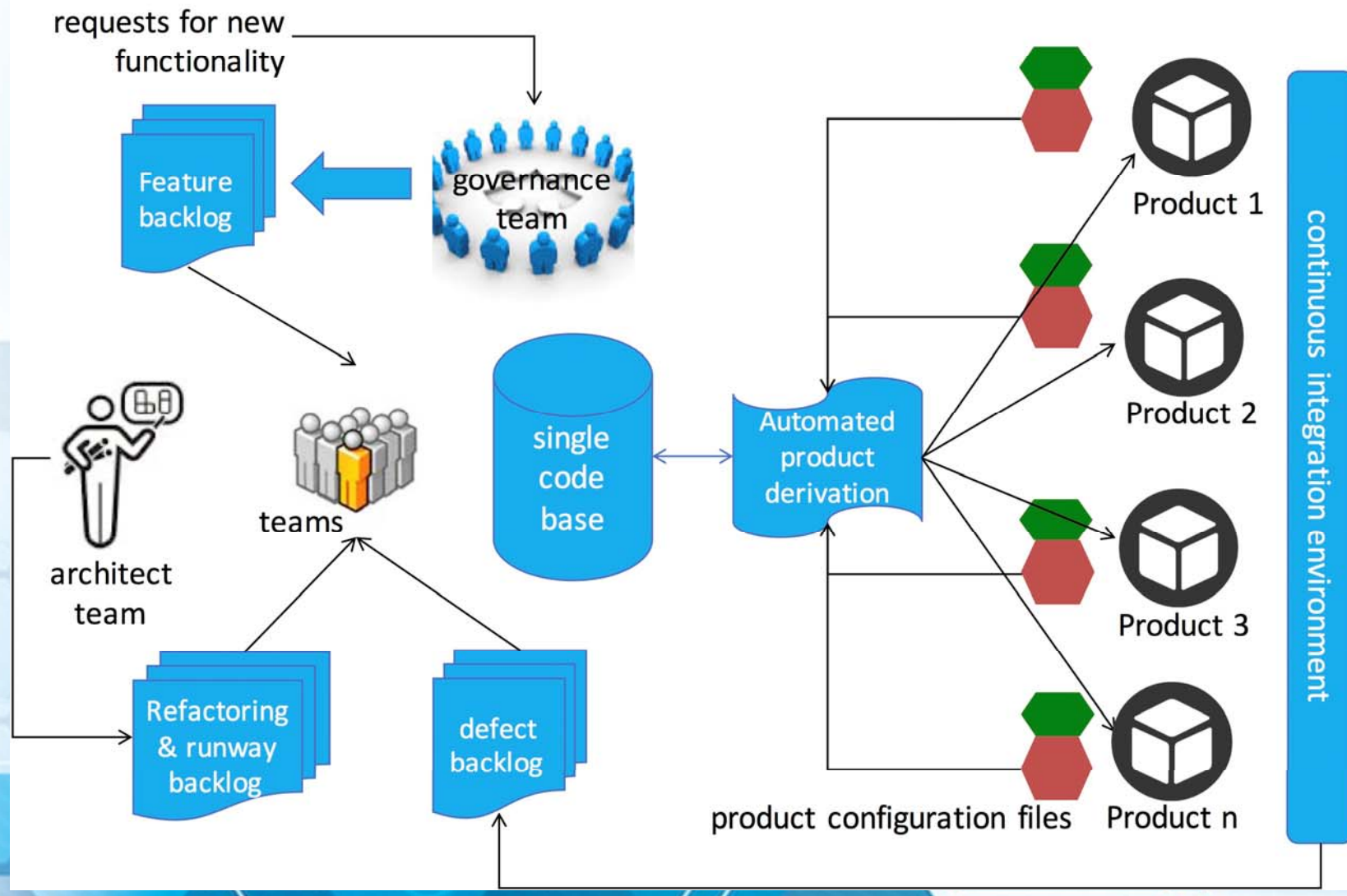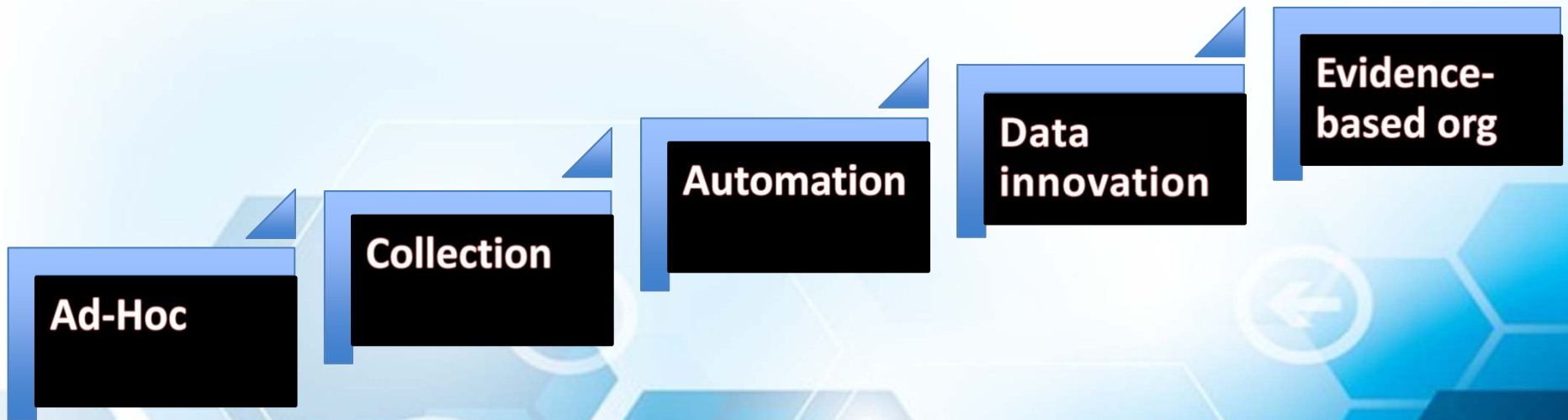
	Collection	Analysis	Reporting	Decision making
Ad-hoc	manual	manual	manual	manual
Collection	automated	manual	manual	manual
Automation	automated	automated	automated	supported
Data innovation	dynamic	dynamic	dynamic	supported
Evidence-based company	dynamic	dynamic	dynamic	automated

"In god we trust, all others must bring data"

- W. Edwards Deming

"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%
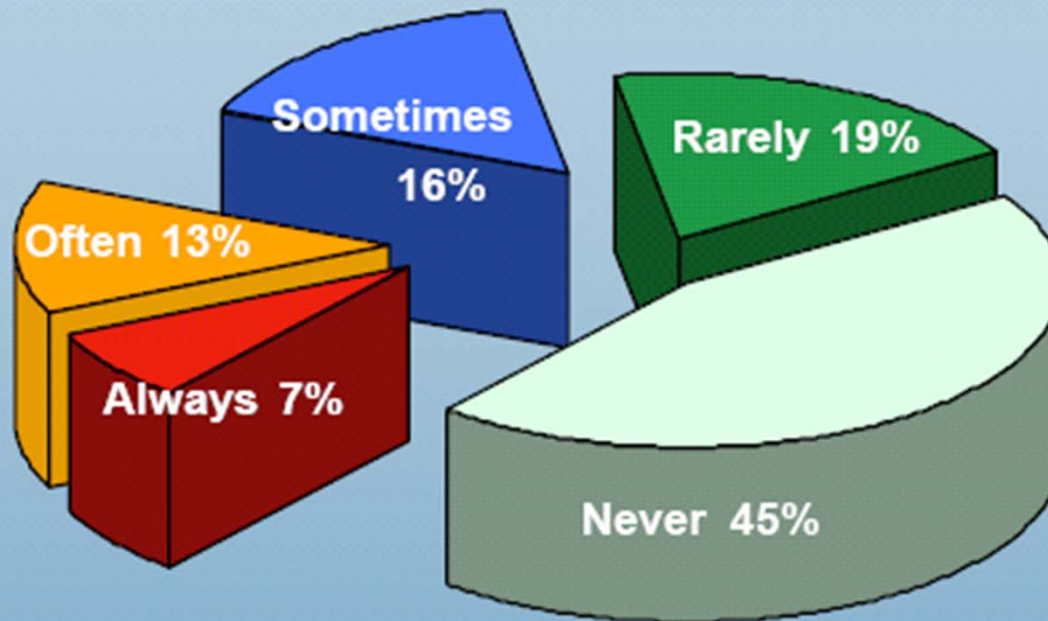
Standish Group Study Reported at XP2002 by Jim Johnson, Chairman

Our Research …

The HYPEX Model

Business strategy and goals

Strategic product goal

Feature backlog

generate

select

Feature: expected behavior (B_{exp})

implement MVF

B_{exp}

Gap analysis

actual behavior (B_{act})

Product

no gap ($B_{act} = B_{exp}$)

relevant gap ($B_{act} \neq B_{exp}$)

Experimentation

Develop hypotheses

implement alternative MVF

extend MVF

abandon
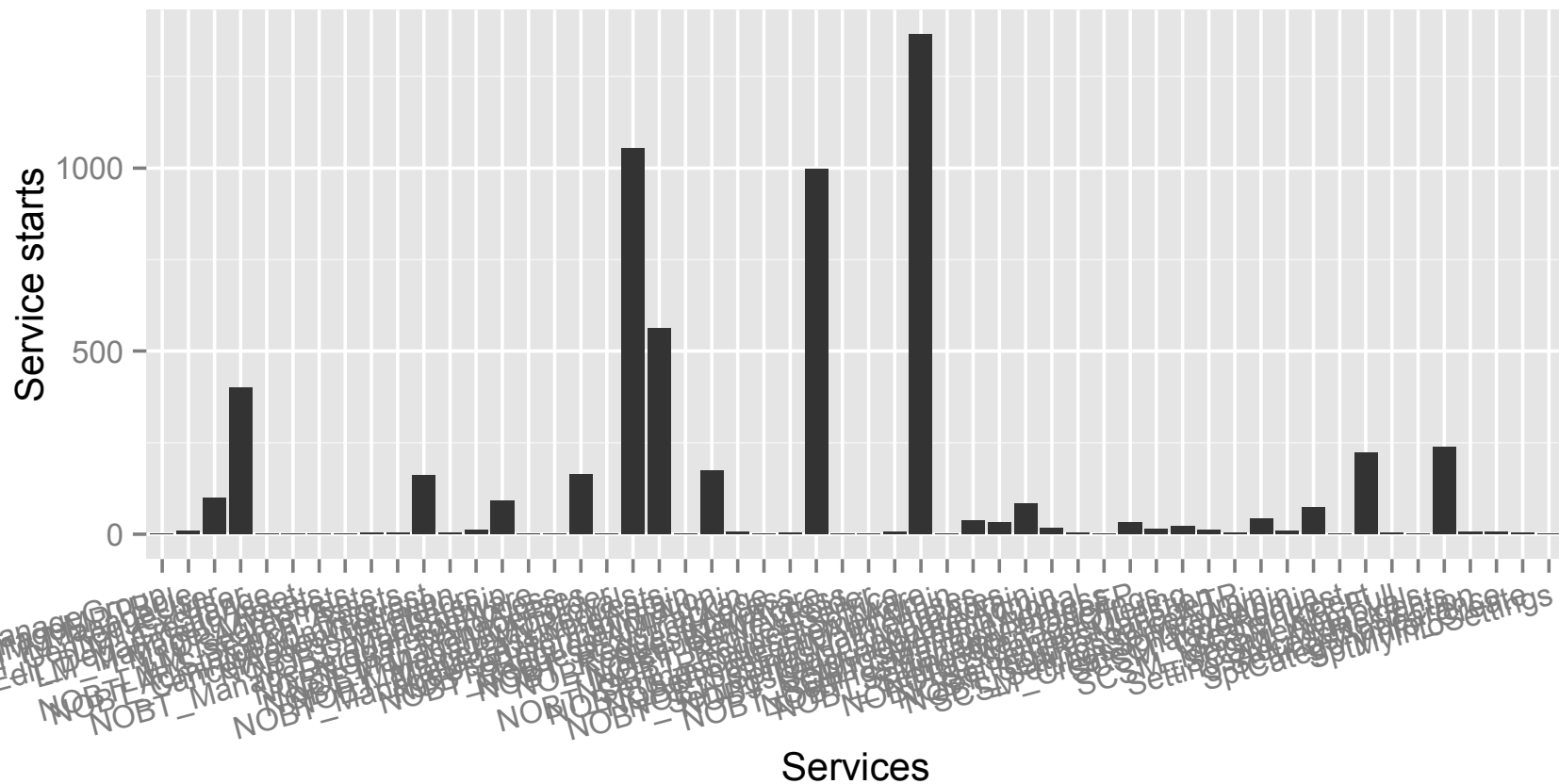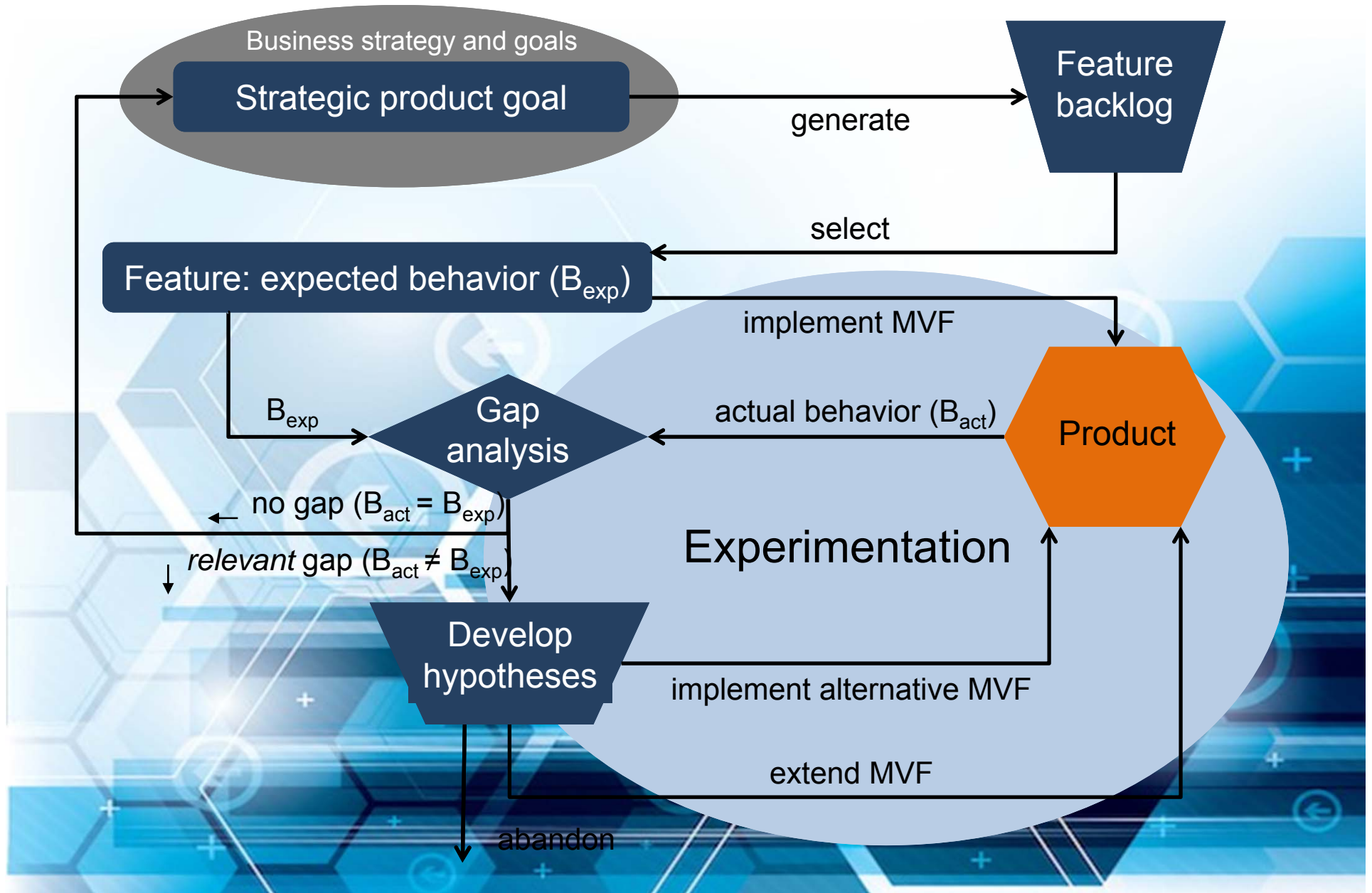
Stairway to Heaven: Ecosystems
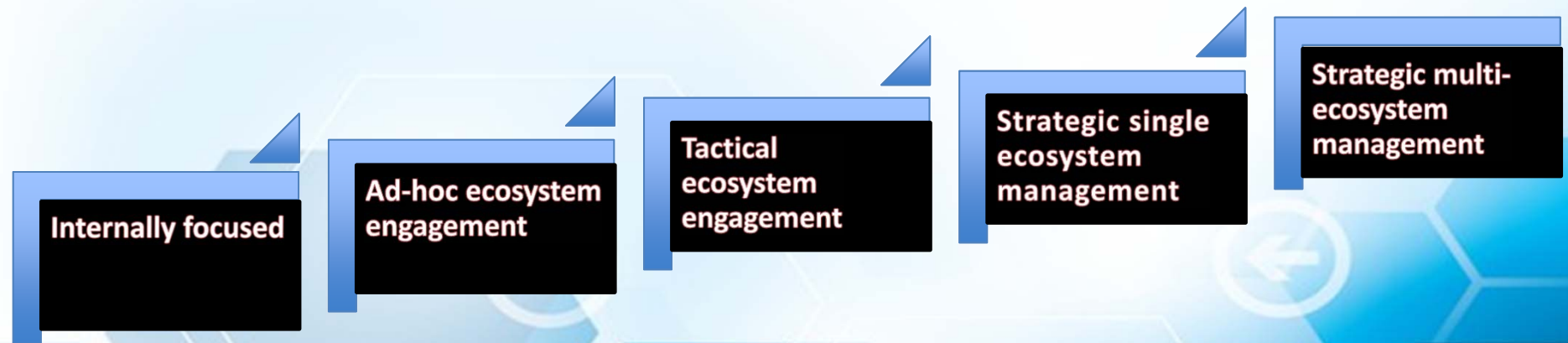
Levels	
Internally focused	do everything in-house unless it is really impossible
Ad-hoc ecosystem engagement	individuals take ad-hoc decisions to engage with ecosystem partners, but local optimization
Tactical ecosystem engagement	ecosystem engagement is centralized, but driven by tactical (rather than 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

3LPM: Three Layer Product Model
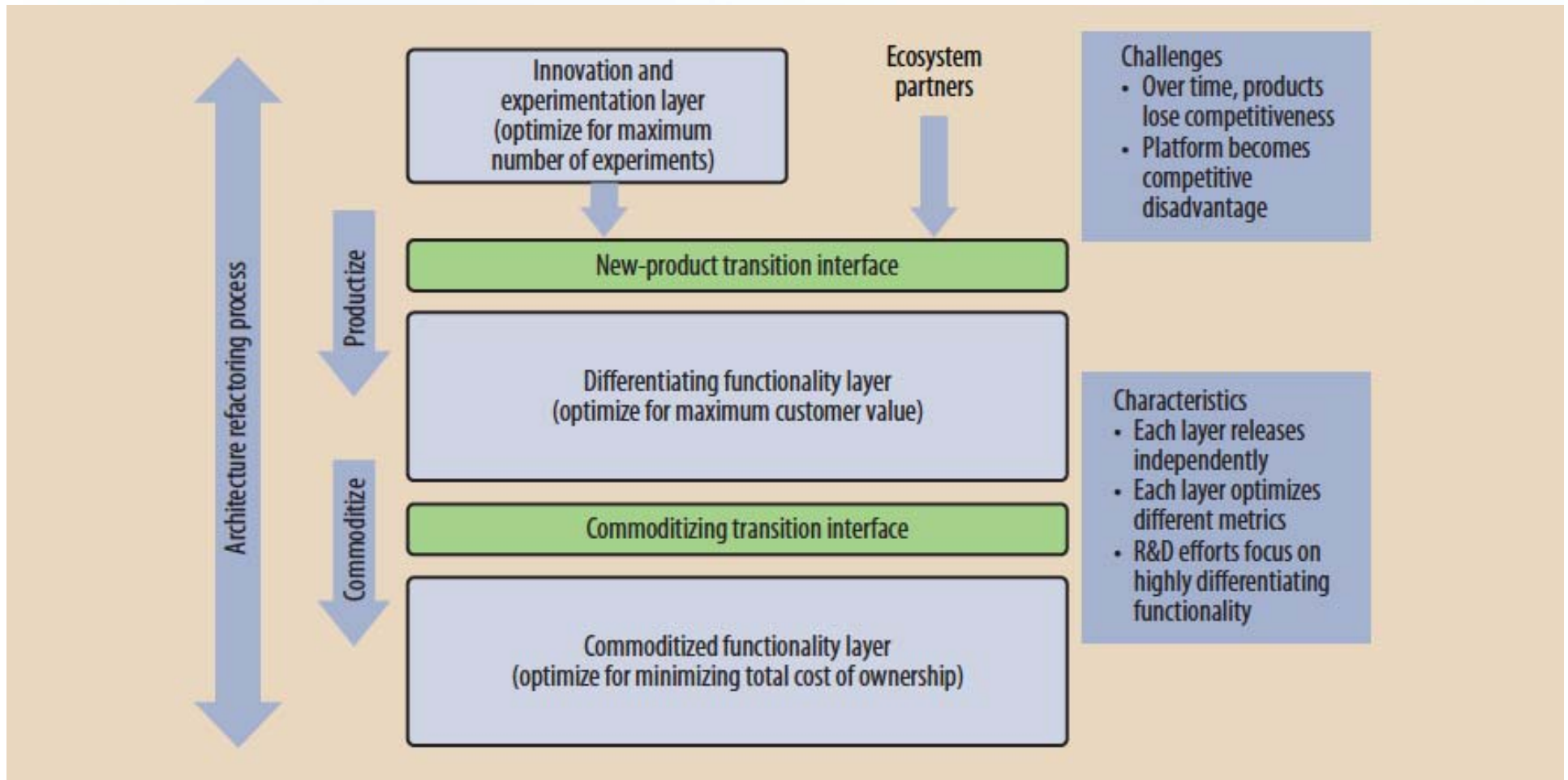
Bosch, J. (2013). Achieving Simplicity with the Three-Layer Product Model, *IEEE Computer*, Vol. 46 (11), pp. 34-39.

What % of R&D for Commodity?
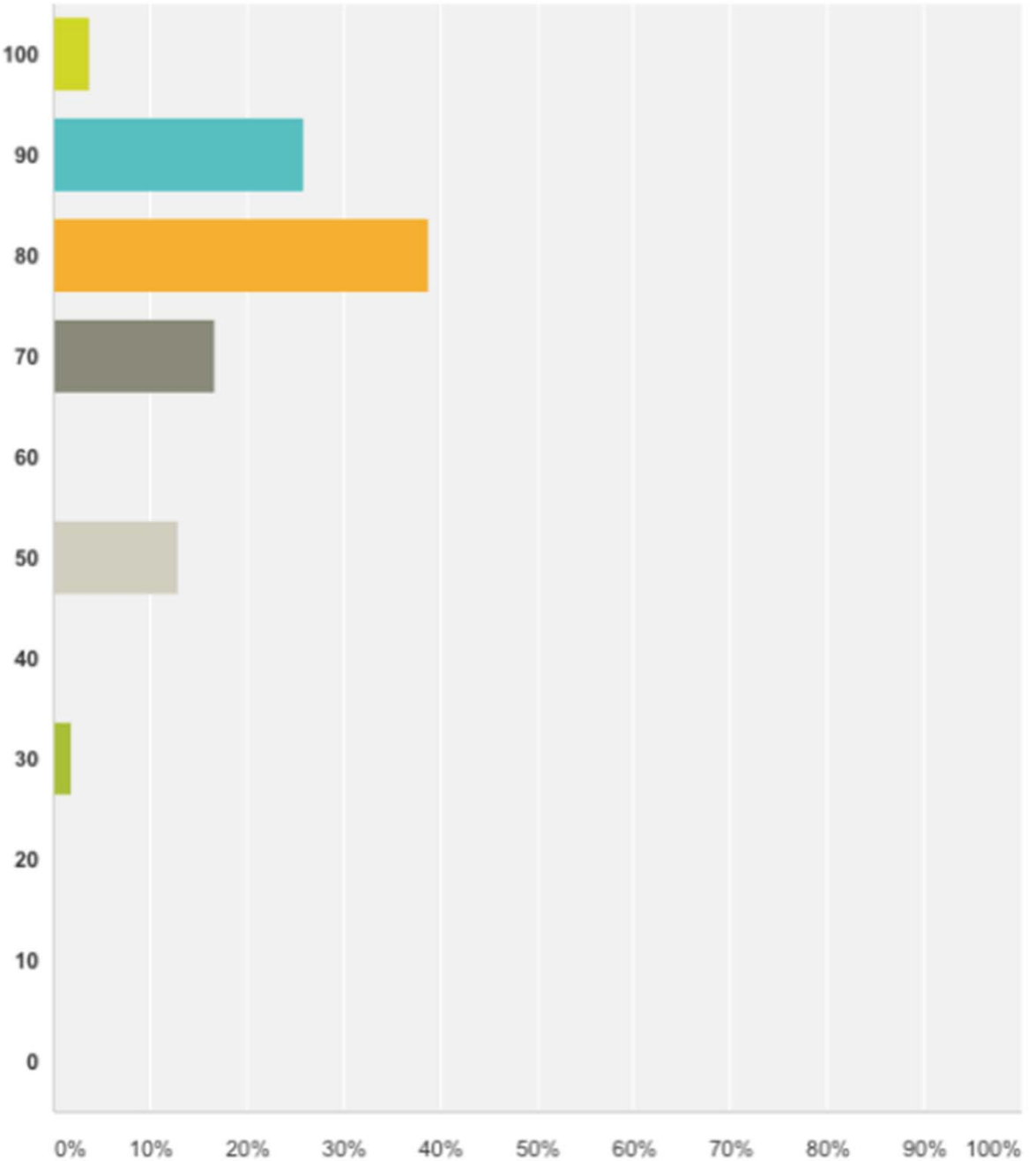
Ecosystem Drivers

External

Internal

Internal

External

Internal

Ecosystem Type

Innovation ecosystem
- **Who:** Customers, 3rd party developers, suppliers
- **What:** Development of new functionality
- **Why:** Share/minimize innovation costs/risks
- **When:** High market uncertainty
- **How:** Open innovation, co-opetition, partnerships
- **Mechanisms:** Product platforming, idea competitions, customer involvement, collaborative design, innovation networks etc.

Functionality transfer

Differentiating ecosystem
- **Who:** Keystone player
- **What:** Optimization and extension of existing functionality
- **Why:** Turn innovations into core product offerings, keep internal control over value-adding functionality, optimize for maximum customer value
- **When:** When innovative functionality have proven valuable for customers
- **How:** Innovation transfer, R&D management, monetizing strategies
- **Mechanisms:** Data-driven development, patents, contracts, licenses etc.

Functionality transfer

Commoditizing ecosystem
- **Who:** Suppliers, competitors, developers
- **What**: Reduce efforts related to old, non value-adding functionality
- **Why:** Share/minimize maintenance costs
- **When:** Functionality that has become so integral to the product that it no longer offers customer value
- **How:** OSS, COTS, inner source, standardization, shared supplier
- **Mechanisms:** Open platforms and API's, connecting services etc.

Ecosystem Characteristics

- Collaborative
- Internal/external
- Exploratory
- Risk prone
- Less control-driven

- Competitive
- Internal
- Efficient
- Risk averse
- Control-driven

- Collaborative
- Internal/external
- Cost-efficient
- Riske averse
- Less control-driven

TeLESM: Three Layer Ecosystem Strategy Model
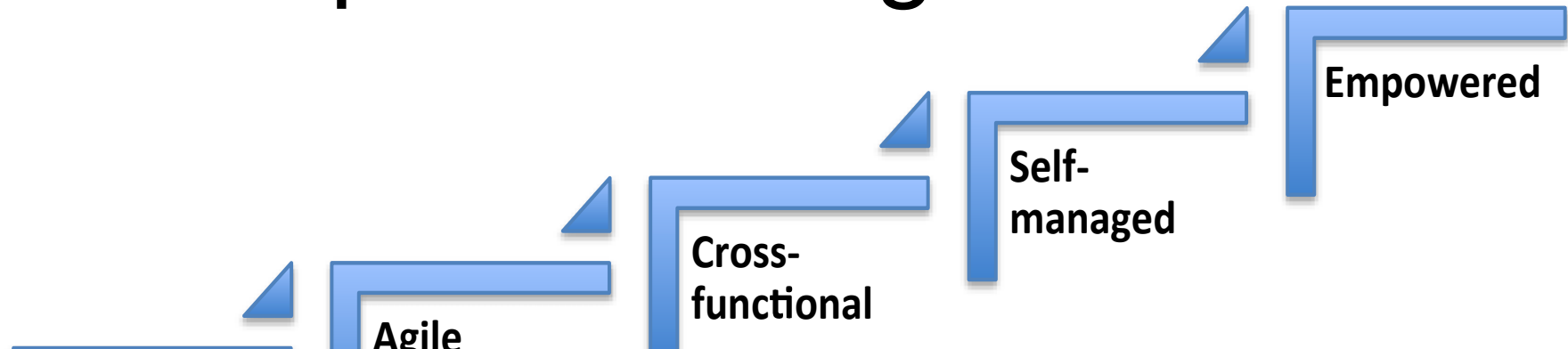
Innovation ecosystem

internal ← — — **collaborative** — — → **external**

- Me-Myself-I Strategy
- Be-My-Friend Strategy

- Customer Co-Creation Strategy
- Supplier Co-Creation Strategy
- Peer Co-Creation Strategy
- Expert Co-Creation Strategy

- Copy-Cat Strategy
- Cherry-Picking Strategy
- Orchestration Strategy
- Supplier Strategy
- Preferred Partner Strategy
- Aquisition Strategy

Differentiating ecosystem

internal ← — — **collaborative** — — → **external**

- Increase Control Strategy
- Incremental Change Strategy
- Radical Change Strategy

- Complementing Strategy

- Platform Control Strategy

Commoditizing ecosystem

internal ← — — **collaborative** — — → **external**

- Rationalized in-sourcing
- Push-Out Strategy

- OSS Creation Strategy
- Partnership Strategy
- OEM partnerships

- COTS Adoption Strategy
- OSS Integration Strategy
- Outsourcing

Empowered Organizations

	Traditional	Agile	Cross-functional	Self-managed	Empowered
Culture	Hierarchical	Hierarchical	Hierarchical	Hierarchical	Empowered
General Mgmt.	Hierarchical	Hierarchical	Hierarchical	Empowered	Empowered
Inter-team (PdM/R&D)	Hierarchical	Hierarchical	Empowered	Empowered	Empowered
Local (R&D)	Hierarchical	Empowered	Empowered	Empowered	Empowered

Hierarchical Organizations

Strengths

- Effective scaling
- Controlling many people from a central position
- Very efficient for repeatable tasks
- Harmonization of processes
- Globalization
- Handles low complexity situations well

Weaknesses

- Slow decision making processes
- Power driven by position; not capability
- Tendency to be internally focused
- Easily gravitates to politics
- Highly resistant to changes
- Challenged by high-complexity situations

Employee Engagement

U.S. Employee Engagement, 2013 vs. 2014

% Employees	2013	2014
Engaged	29.6	31.5
Not engaged	51.5	51.0
Actively disengaged	18.8	17.5

GALLUP

U.S. Employee Engagement, by Generation

% Employees engaged

	2013	2014
Millennials	27.5	28.9
Generation X	29.6	32.2
Baby boomers	30.9	32.7
Traditionalists	38.3	42.2

GALLUP

Sweden (2013)

Engaged	16%
Not engaged	73%
Actively disengaged	11%

Gallup uppskattar att oengagerade medarbetare kostar USA varje minst 450 miljarder dollar varje år. Tyskland går miste om minst 151 miljarder och Storbritannien 83 miljarder.

Empowerment: Principles

- **Self management**
  - Nobody is in command.
  - Coordination mechanisms, but no boss
  - Natural leadership leads to spontaneous, temporary hierarchies
- **Wholeness**
  - No acting to suit your boss/fit the culture
  - Be yourself at work
- **Evolutionary purpose**
  - No top-down strategy
  - Wisdom of the crowds

Characteristics

- **Roles**: people can shoulder one or more roles, independent on place in the organization
- **Activities**: coordinate the work of one or more roles
- **Advice process**: everyone has complete autonomy to make decisions pertain to their role or roles. Stakeholders need to be asked for advice though. *Note: this is NOT consensus!*
- **Agreements**: People can negotiate agreements to coordinate work, agree on SLAs and other relevant factors. Agreements are entered voluntarily.
- **Evolution**: Roles, activities and agreements evolve constantly in mutual agreement

Examples

- Agile software development

- Holistic organizations

- Holacracy

- Exponential organizations

Holistic/authentic

Post-modern / Information

Scientific / Industrial

Agrarian

Tribal

Exponential Organizations

MTP
MASSIVE TRANSFORMATIVE PURPOSE

Interfaces — Staff on Demand
Dashboards — Community & Crowd
Experimentation — Algorithms
Autonomy — Leveraged Assets
Social — Engagement

IDEAS   SCALE

Left Brain
• Order
• Control
• Stability

Right Brain
• Creativity
• Growth
• Uncertainty
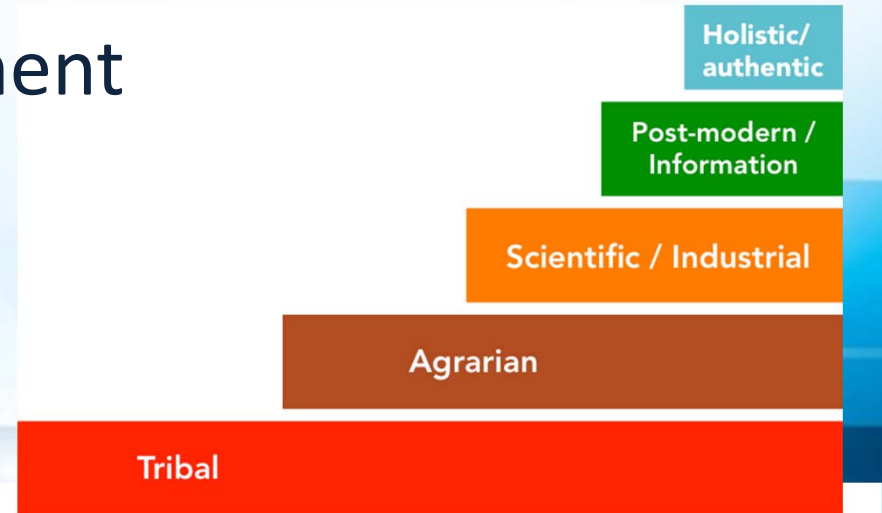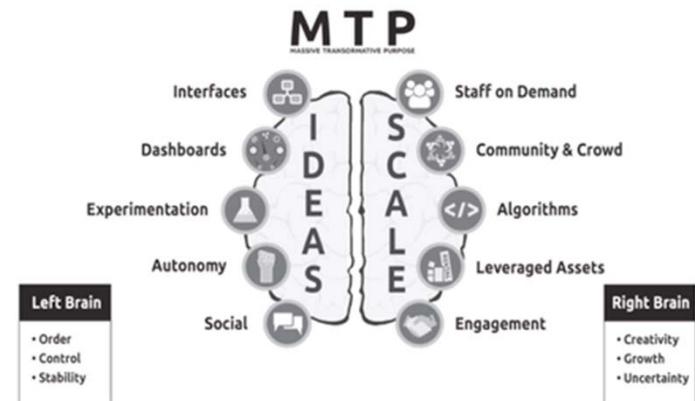
Empowerment

- **Principles** over *Orders*
- **Personal leadership** over *Leader – Follower*
- **Trust** over *Audits*
- **Customer first** over *Organization structure first*
- **Team appointed managers** over *Manager appointed teams*
- **Diversity** over *Homogeneity*
- **Agility** over *Long-term planning*
- **Emergent strategy** over *Top-down strategy*

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- Towards a New Business Operating System
  – Speed
  – Data
  – Ecosystems
  – Empowerment

- Conclusion

"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

Empowered Organizations

- We are moving towards a new business operating mechanism focused on **empowerment** and **autonomy**

- Teams and individuals employ local decision making, peer-to-peer alignment, choose their own leaders and innovate and improve constantly

Interested In Learning More?
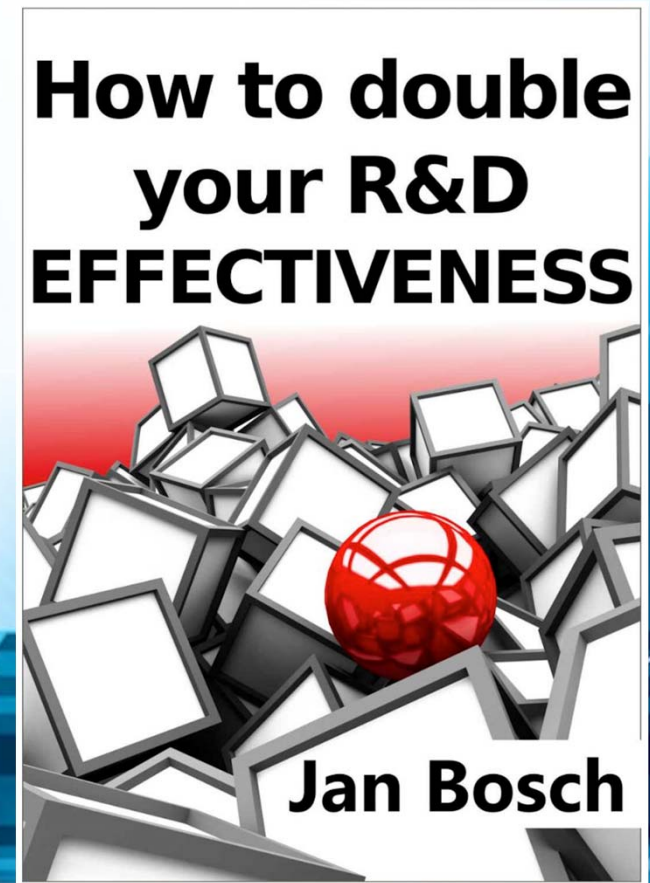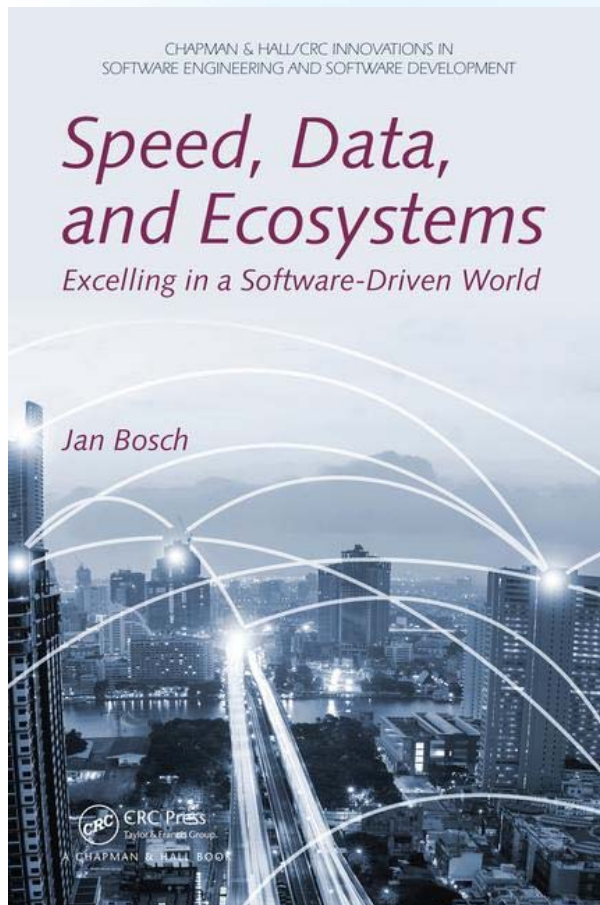
(draft, upcoming)

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www.janbosch.com/blog

Upcoming Events

16th Annual Conference on Systems Engineering Research

Hosted by: UNIVERSITY OF VIRGINIA, School of Engineering and Applied Science Department of Systems and Information Engineering
May 8 & 9, 2018

- Theme: "Systems in Context"
- Key Dates:
  - **Paper Submission: February 9, 2018**
  - Paper Notification: March 16, 2018
  - Final Paper Submission Due: April 13, 2018
  - **Conference Registration Opens: February 1, 2018**
    - o Direct link to registration web page: http://edas.info/r24260
- POCs:
  - Peter A. Beling: pb3a@virginia.edu
  - William T. Scherer: wts@virginia.edu
  - Cody H. Fleming: fleming@virginia.edu
- Venue: Boar's Head Resort
  - Reserve rooms by phone at (866) 996-7504 (referencing CSER 2018) or online at this link.
- **For more information visit: https://cser2018.com/.**
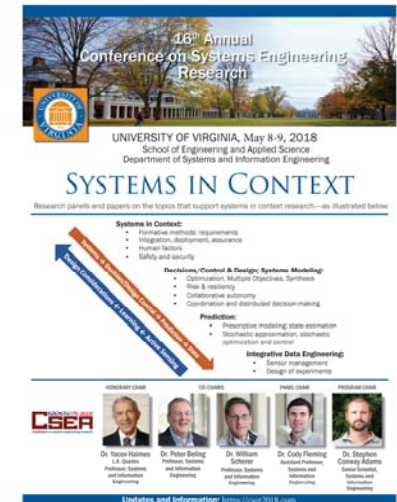
UPCOMING TALKS:

"Successfully Applying Agile Methods for High-Criticality Systems" Series

Robin Yeman, Lockheed Martin Fellow, Lockheed Martin (LM) Information Systems and Global Solution, Agile/DevOpSec SME

April 4 | 1:00 PM ET

How Do You Use Agile Methods on Highly-Critical Systems that Require Earned Value Management?

Phyllis Marbach, INCOSE LA Chapter President; Senior Software Engineer at Boeing – Retired

June 6 | 1:00 PM ET | REGISTER NOW

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"Engineering System Software Qualities" Series

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December 5, 2018 | 1:00 PM ET

CONTACT

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Webinar Coordinator: Ms. Mimi Marcus, Stevens Institute of Technology – mmarcus@stevens.edu

Thank you for joining us!

Please check back on the SERC website for today's recording and future SERC Talks information!