



**Aha Autonomy**

# Robotic Intelligence - Subsumption Architecture

## Revolutionizing Agile Scaling

Sue Ryu

September, 2023

## Sue Ryu MSc., Enterprise Agile Coach

- Passionate Agilist since 2008
  - Rally came to NYC promote Scrum/Agile when I was a process methodologist helping an energy billing software firm with the organization process
  - Have coached and guided many org like ADP, Accenture adopt agile
- XP in early 2000
- Before Agilist Held a variety of roles in different industries
  - MSc in Computer Science from NYU
  - Systems Analyst/Programmer for Bell Core/Bell Lab – Telecom, Financial Industries (Deutsch Bank, NYSE, brokerage firm), Internet StartUp, and more
  - Project Mgr, Process Methodologist

# Agile is perfect for a new product development!



## Why?

Adapt quickly to market changes

Ability to respond to changes quickly

Faster Time to Market

Survival & Profits!



## How?

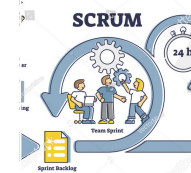
Empowered Autonomous Teams

Collaboration

Transparency, Inspect & Adapt

Continuous Improvement

Rapid Feedbacks



## Scrum

Great for one team for one product

Need many teams to develop products

# The BIGGEST Challenge w Scaling Scrum is Managing Dependencies

- Dependencies
  - EAT
    - **Autonomy**
    - Lack of autonomy leads to
      - Poor Empowerment
      - Poor Commitment
      - Poor Accountability
      - Poor Team Moral
      - No Faster Delivery
      - **Scrum/Agile just BREAKS APART!**

© All Rights Reserved. Please do not use, share, or post to the web without permission from Aha Autonomy, LLC.

# Managing Dependencies via Subsumption Architecture

- Problem
  - Many Scaling Frameworks (SAFe, LeSS, Scrum at Scale) manage the dependencies through roles & meetings
  - They don't lead to autonomous teams
  - Dependencies Map
  - Agile breaks down
- Solution (Subsumption Architecture)
  - Enable
    - Autonomy on the team levels
    - Collaboration across the entire organization

9/27/23

[www.AhaAutonomy.com](http://www.AhaAutonomy.com)



Mike Beedle' solution to scaling agile –  
Applying the robotics' architecture –  
Subsumption Architecture – to scaling agile.

**Met him in 2016 at Meetup in NYC – Improved ES for Biz Agility**

Enterprise Scrum Instructor, 2017

# Why Subsumption Architecture for Scaling Agile?

---

Autonomy, Autonomy, Autonomy – Foundation of becoming agile!

---

Decentralized Decision Making

---

All at Once Management

---

Ability to respond to changes quickly

---

Synergy & Alignment throughout the whole organization

---

Faster Time to Market

---

Happy teams, customers, stakeholders

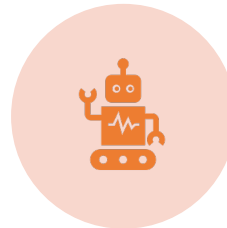
---

Survival & Profits!

# How Jeff Sutherland (co-creator of Scrum) learned about Subsumption Architecture?



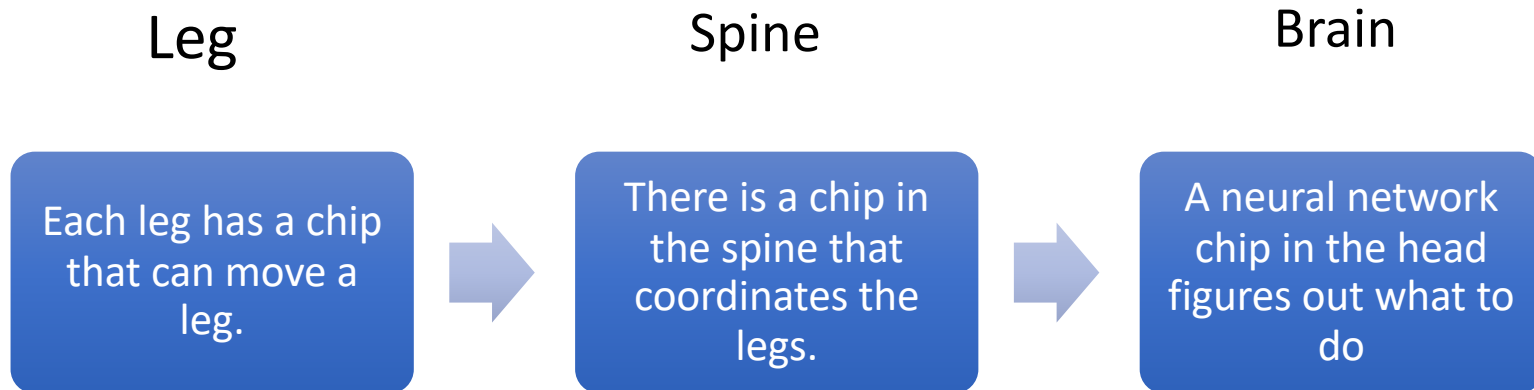
Rodney Brooks and Jeff Sutherland  
Interaction in early 1990 – Jeff rented an  
office space to iRobotics - use of the  
subsumption architecture for robots



Rodney Brooks – A Radical discovery after  
30 years of trying to build a robot using an  
intelligent system. The best they had been  
able to do was a smart chess program.  
Then he and his team discovered the  
Subsumption architecture. Game Changer



# How does a robot walk using the subsumption architecture?



“Before you turn the robot on the chip is blank. The chip collects data as each level’s sensor sends its own to the chip as it wanders around. **There is no database. The world is the data and all data is created by sensors.**” – Prof. Rodney Brooks

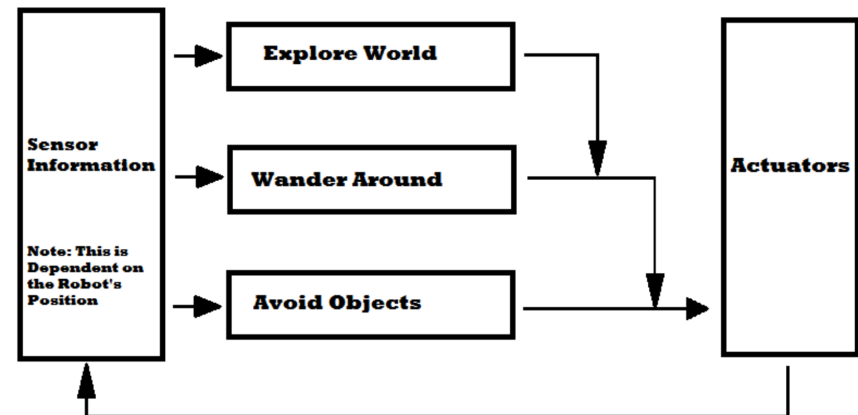
# How does a Robot use the Subsumption Architecture?

- 3 Main roles – **Layers, Sensors, Actuators**
- Sensors – sends signals to all the layers as it roams
- Actuators
  - Enable the subsumption layers to **interact with the physical world**
  - Enable the robot to ACT appropriately and accordingly to the most recent and relevant information it received from the sensors.

**Actuators, Sensors, layers all work together replacing the role of a central processor.**

No Central Processor

A robot must be able to know how to avoid an object before it can wander around. Once it can wander around, it can explore the world.



it is layered so that the higher layers subsume the lower layers. The higher layer consumes what the lower layer produced and does its own thing while listening to the sensors.

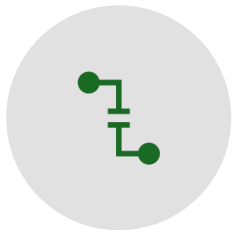
# Keys to the Robotics' Subsumption Architecture



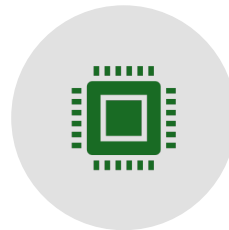
Hierarchical Subsumption  
Layers **Autonomy on its  
own layer**



Learning from past  
behaviors



Controlled by sensors &  
Acted by Actuator



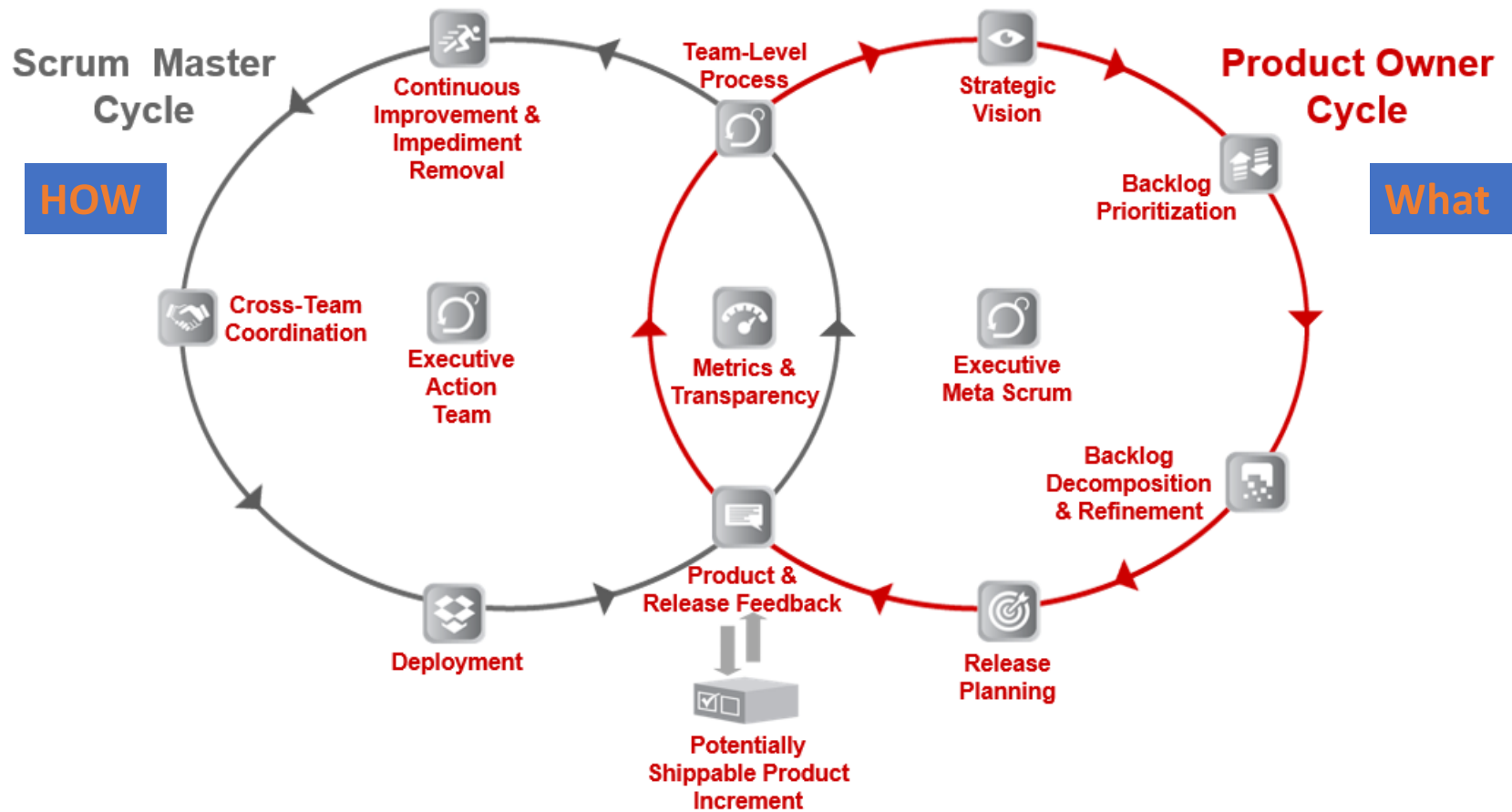
No Central Processor

# Jeff applied the Subsumption only to the team level!

He liked the idea of how a robot can learn from itself and become better and better. He wanted his Slow programmers becoming better.

The real beauty of the subsumption architecture comes when and where a higher layer subsumes the lower layer till all the parts work like a whole.

# Scrum@Scale Cycles



Scrum@Scale doesn't utilize the beauty and essence of the subsumption architecture **instead it divides Scrum into two How and What. Impedes teams to be autonomous !**

Mike's approach is using the  
subsumption all the way ....  
Apply it **n-level to** the whole organization  
as well as sensors & actuator functions

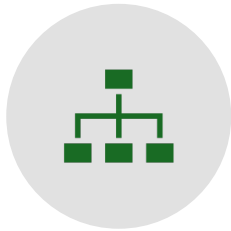
Of the Subsumption Architecture.

“Ideally, all hierarchy is in  
SUBSUMPTION.”

- Mike Beedle



# Now, let's take a look at how you can apply the subsumption architecture for an organization

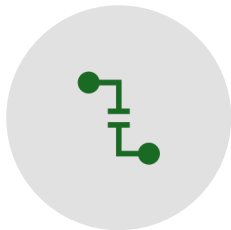


**Subsumption Layers** – What kind of subsumption hierarchy would make sense

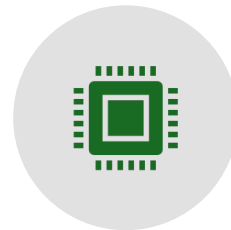
**Autonomy** on its own layer



Learning from past behaviors – Insert a blank chip and it records its behaviors and learn from them



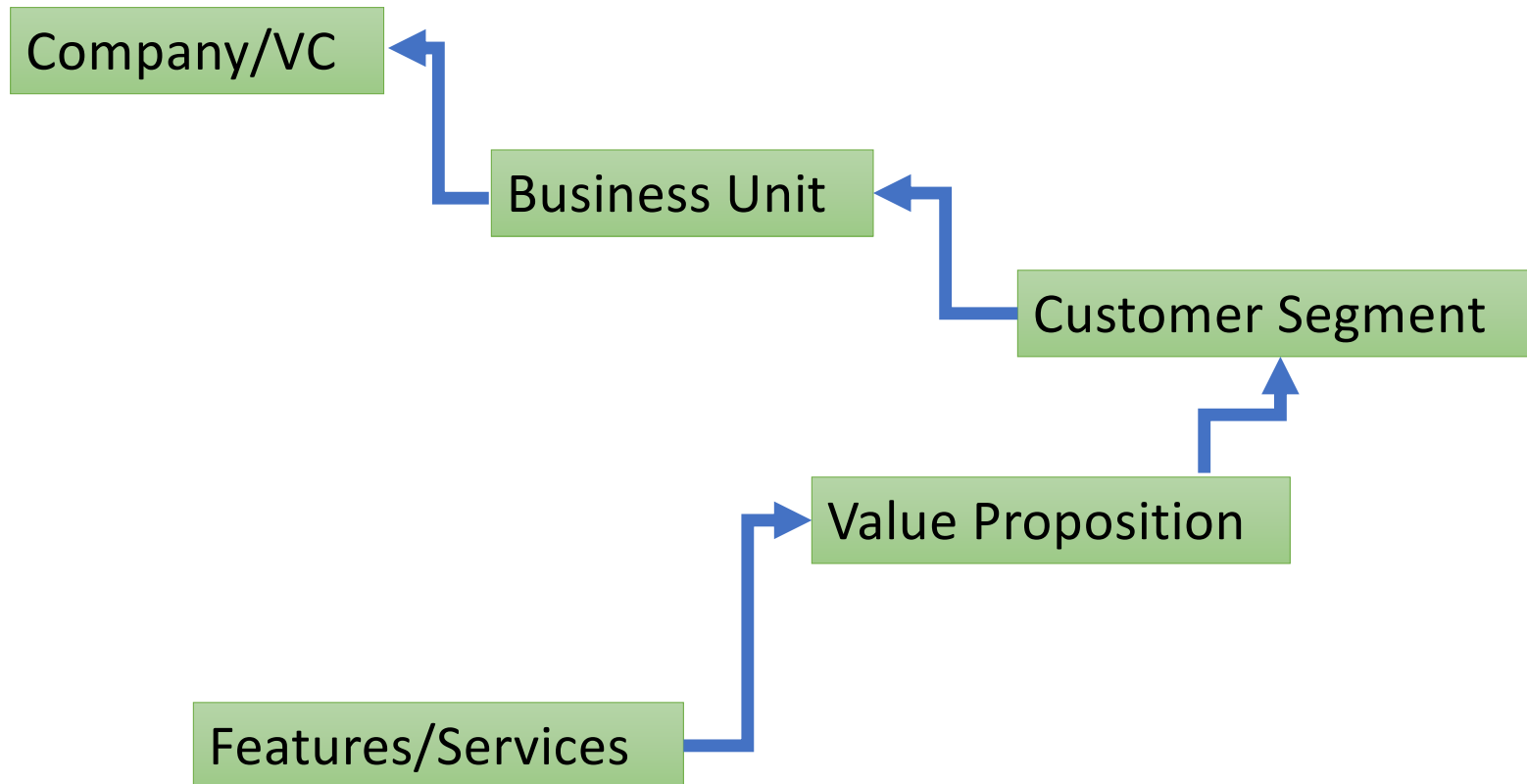
Controlled by sensors & Acted by Actuator based on the signal received from Sensors – Send the signals to all layers allowing to react immediately & Actuators acts upon them.



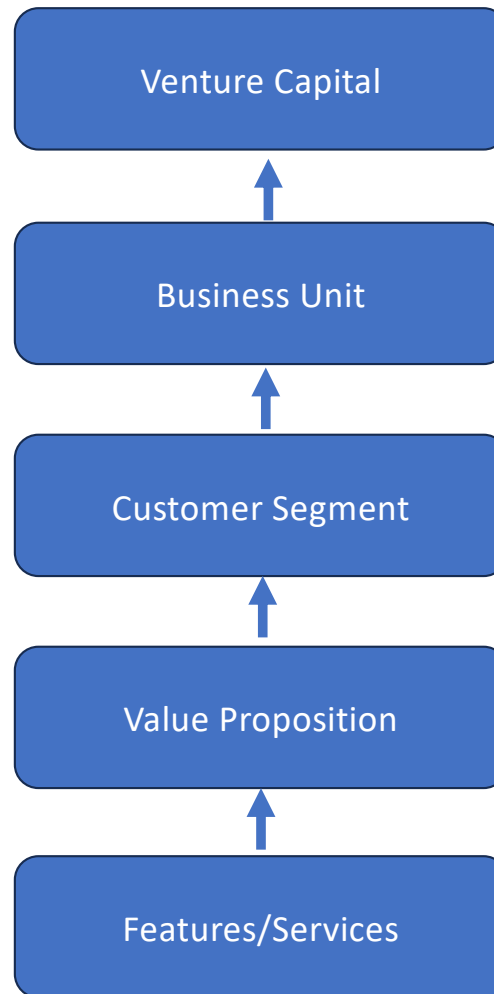
No Central Processor – Instead Actuator control the lower layer based on the signals received from sensors



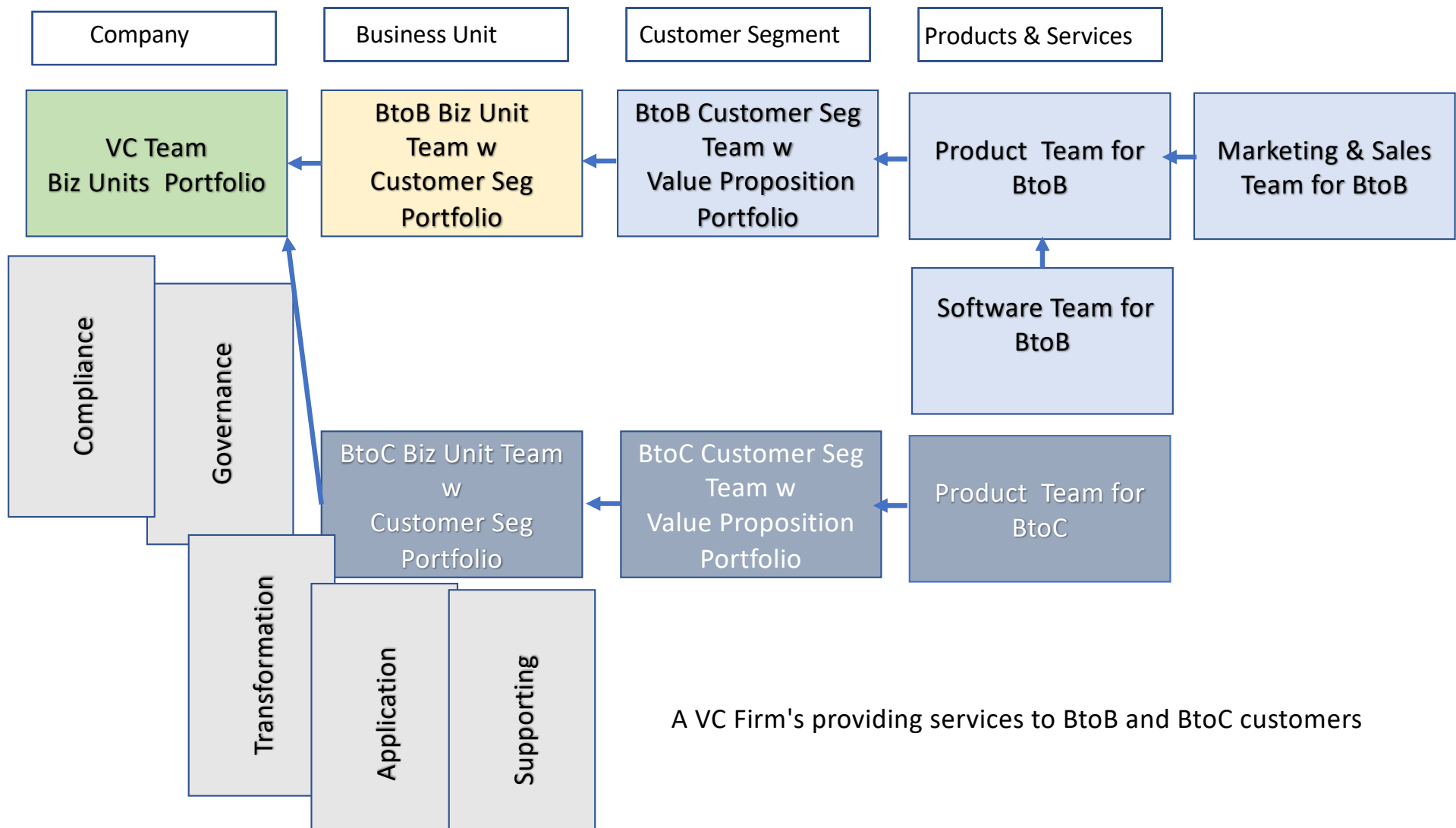
## Bottom up approach - Subsumption Layers



## Subsumption Layers

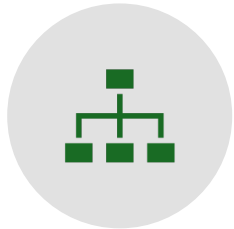


Copyright © All right Reserved. Please do not use, share, or post to the web without permission from Aha Autonomy, LLC.



A VC Firm's providing services to BtoB and BtoC customers

# Why use customer segment?

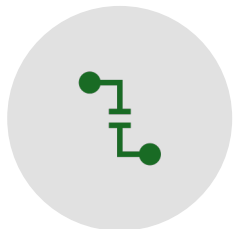


How to divide into subgroups so that the higher layers subsume the lower layer **Autonomy on its own layer; Hierarchy of Layers**

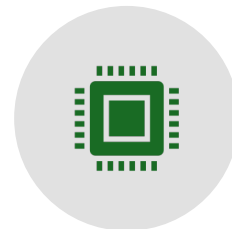
**In ES - By Customer Segment**



Learning from past behaviors – Insert a blank chip and it records its behaviors and learn from them



Controlled by sensors & Acted by Actuator based on the signal received from Sensors – Send the signals to all layers allowing to react immediately & Actuators acts upon them.



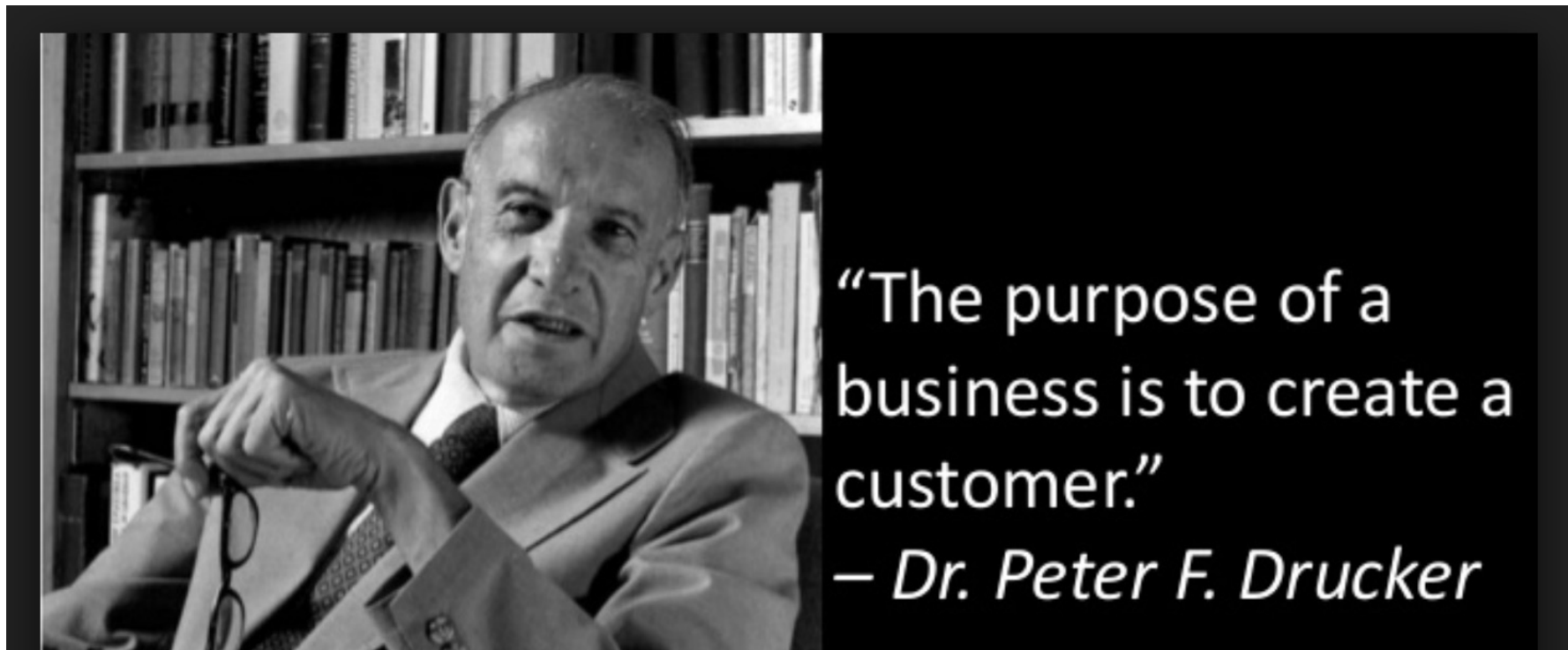
No Central Processor – Instead Actuator control the lower layer based on the signals received from sensors

## Why? Answers can be found from two very **influential management thinkers**

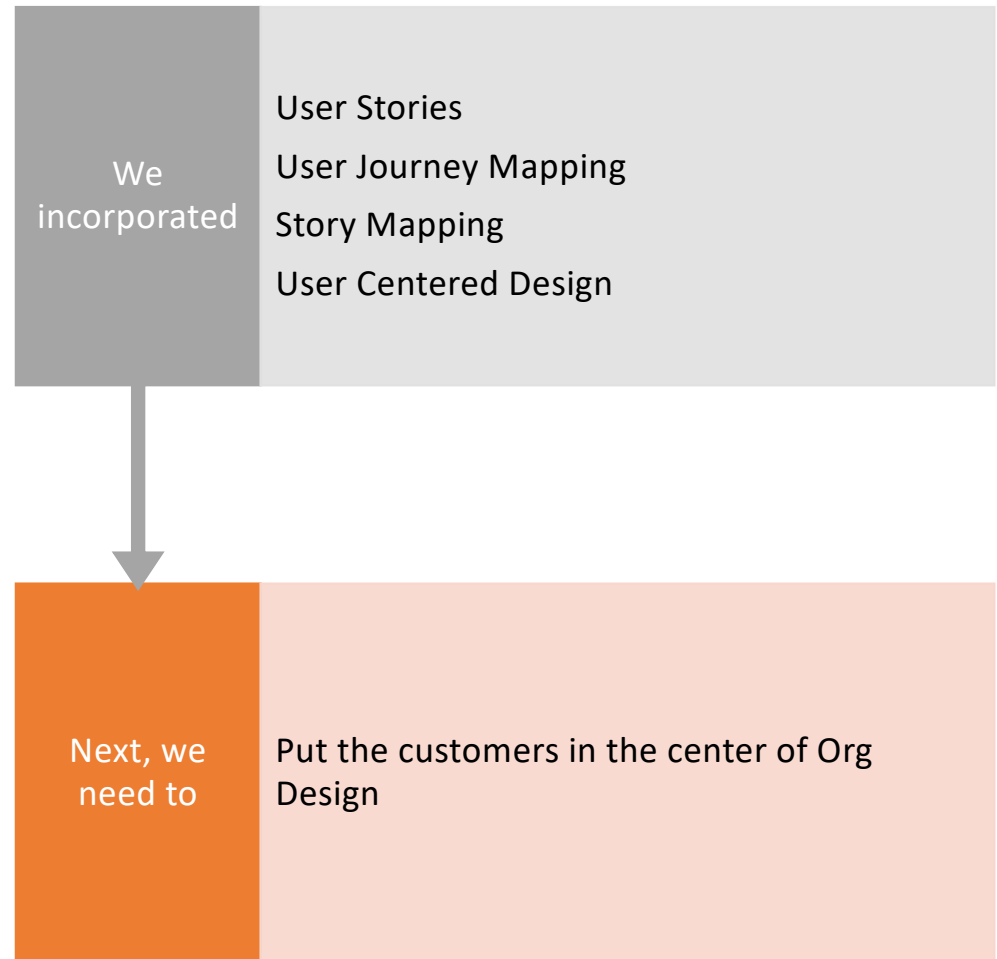
Peter Drucker

Clayton  
Christensen

# Peter Drucker

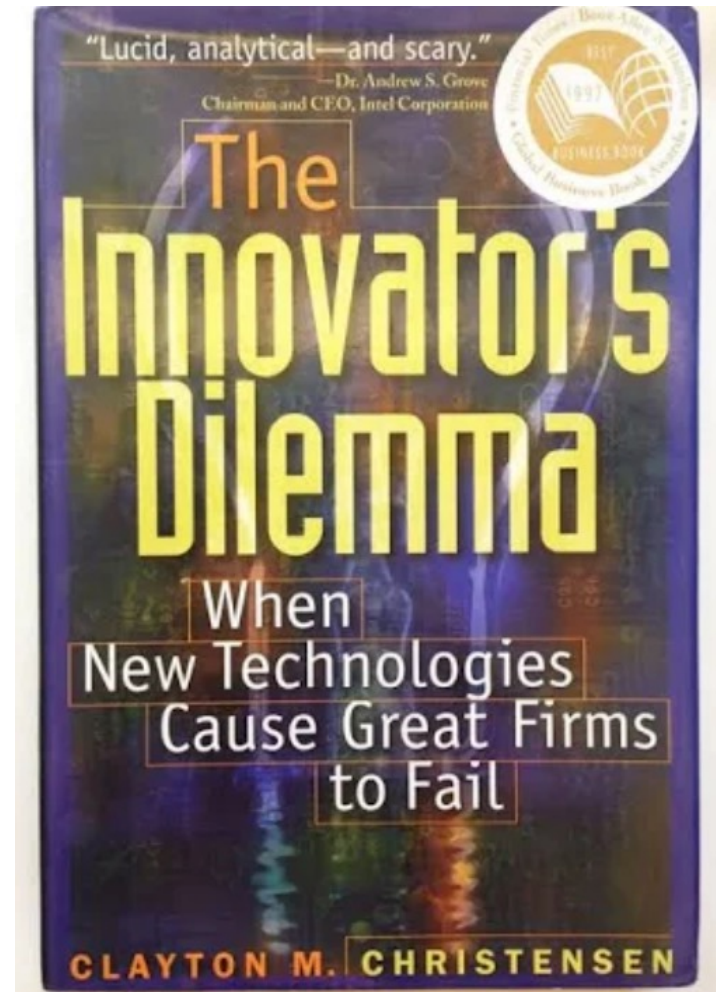


We still haven't put the customers - paying customers in the center of organization design.



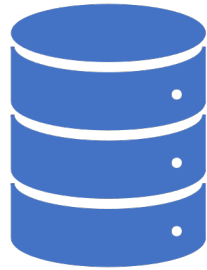
In his book, he talks about value networks and

Not following value networks often leads to best firms failing in the face of disruptive innovation..





## Hard disk drive industry to study why best firms fail in the face of disruptive innovation. Published the book in 1997



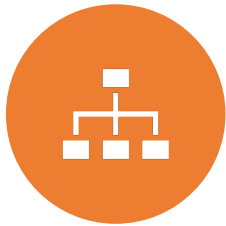
Clayton chose **Hard Disk Drive** after a sage advise from a friend.



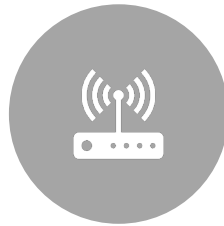
“Those who study **genetics** avoid studying humans. Because new generations come along only every **30 years** or so, it takes a long time to understand the cause and effect of any changes. Instead, they study **fruit flies**, because they are **conceived, born, mature, and die all within a 1 day**. If you want to understand why something happens in business, study the **disk drive industry**. Those companies are the closest things to fruit flies that the business world will ever see.”

## Why Established Firms Fail in the Face of Disruptive Innovation?

Clayton says in his book, common explanations from innovators, scholars, consultants are either:



ON MANAGERIAL, ORGANIZATIONAL, AND CULTURAL RESPONSES TO TECHNOLOGICAL CHANGE



THE ABILITY TO DEAL WITH RADICALLY NEW TECHNOLOGY



# Clayton - The history of disk drive industry tells us a different story:

“As we saw, the nature of the technology involved (components versus architecture and incremental versus radical), the magnitude of the risk, and the time horizon over which the risks needed to be taken had little relationship to the patterns of leadership and followership observed. Rather, if **their customers needed an innovation**, the leading firms somehow mustered the resources and wherewithal to develop and adopt it. Conversely, if their customers did not want or need an innovation, these firms found it impossible to commercialize even technologically simple innovations.”

Christensen, Clayton M.. The Innovator's Dilemma (Management of Innovation and Change) (p. 85). Harvard Business Review Press. Kindle Edition.

# Established firms failed not because they didn't develop the technology first.

In fact, they were the first to develop **the prototypes**. His finding **consistently** showed that they failed because: They were caught in between **two different value networks**.

# Value Network

“The concept of the value network—the context within which a firm identifies and responds to customers’ needs, solves problems, procures input, reacts to competitors, and strives for profit—is central to this synthesis.”

Christensen, Clayton M.. The Innovator's Dilemma (Management of Innovation and Change) (p. 85). Harvard Business Review Press. Kindle Edition.

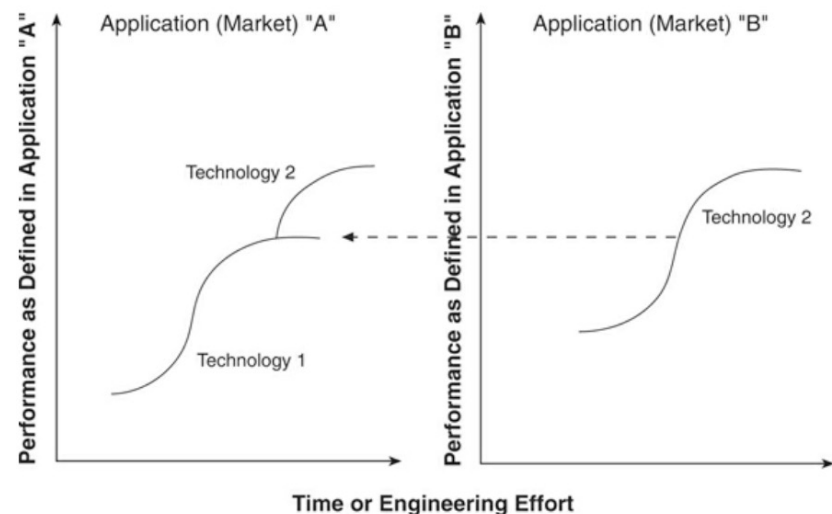
## Needs for Desktop Customers vs Laptop Customers

- Desktop customers - More storage and faster speed vs the size of a disk
- Laptop customers - Small size over more storage and faster speed. In fact, they are willing to pay more for a small disk.

They failed because of **competing for resources** – they often put their current customers needs first rather than the new market’s customers needs.

This is the reason that **they need to be completely separately from each other.**

Figure 2.6 Disruptive Technology S-Curve



Source: Clayton M. Christensen, "Exploring the Limits of the Technology S-Curve. Part I: Component Technologies," *Production and Operations Management* 1, no. 4 (Fall 1992): 361. Reprinted by permission.

# Why Established Firms Fail in the Face of Disruptive Innovation?



## Held Captive by their current customers

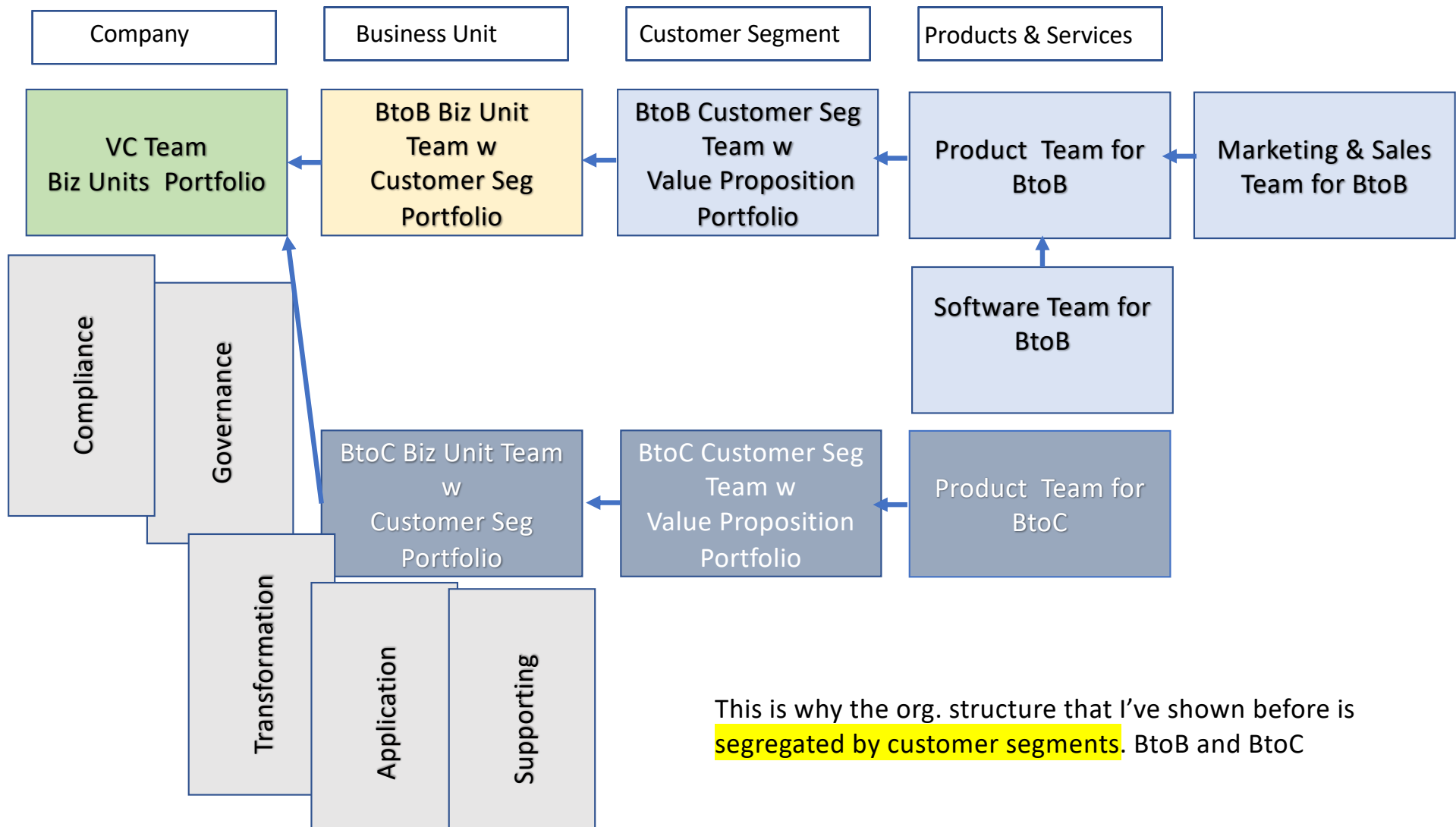
Listening to their CURRENT customers often leads them to enter the disruptive industry late.



## Not a rational financial decision for the firms to make investment and put resources into the emerging market

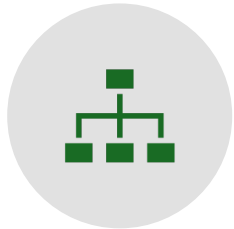
they usually have **lower margins and lower profits**  
disruptive technologies typically are first commercialized in **emerging or NEW market**

**By the time they make the strategic commitment to enter the emerging market, it is too late!**





# Robotic/Subsumption Architecture - Learning from past behavior

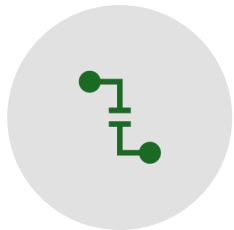


How to divide into subgroups so that the higher layers subsume the lower layer **Autonomy on its own layer; Hierarchy of Layers**



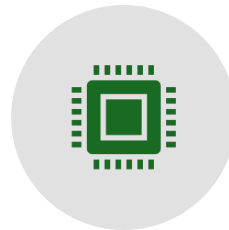
**Learning from past behaviors – Enterprise Scrum is based on Scrum; Transparency, Inspect & Adapt.**

**Transparency – Scrum Board and Canvases**



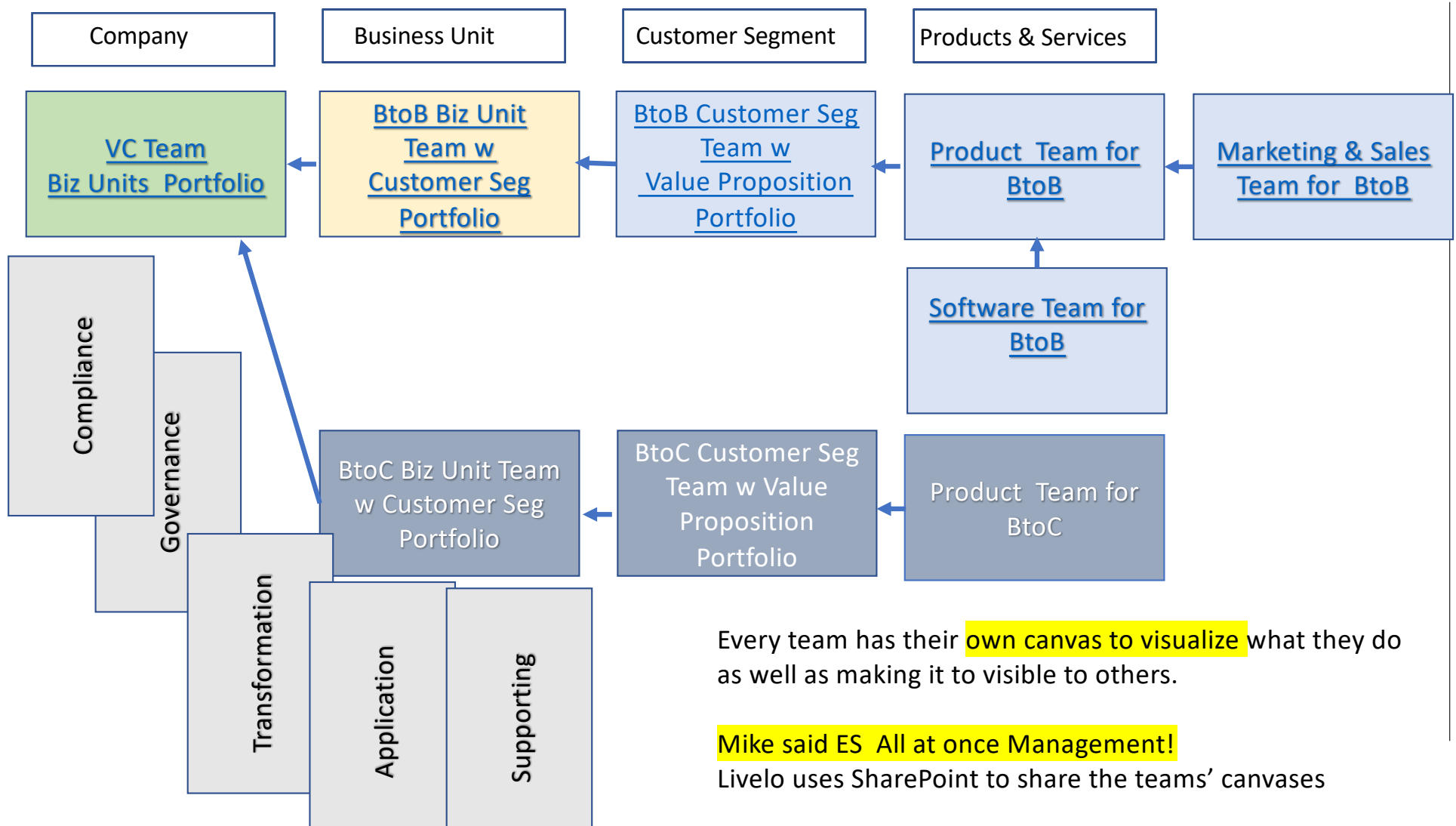
Sensors & Actuator

ES – Canvases - Value Network, Surfers



No Central Processor – Instead Actuator control the lower layer based on the signals received from sensors

Copyright © All right Reserved. Please do not use, share, or post to the web without permission from Aha Autonomy, LLC.



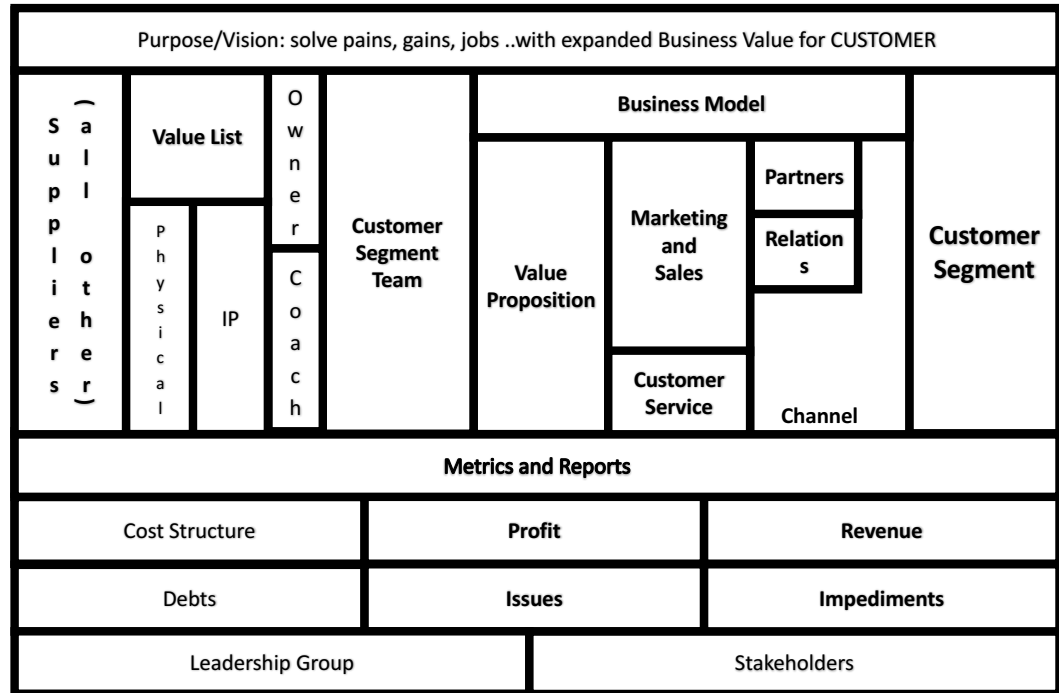
Every team has their own canvas to visualize what they do as well as making it to visible to others.

Mike said ES All at once Management!

Livelo uses SharePoint to share the teams' canvases

# Product Team Canvas

## ES – Business Model Canvas



February 10, 2018

Copyright Enterprise Scrum Inc. DO NOT REPRODUCE WITHOUT PERMISSION.

Like A BMV

Delivering Value Proposition for one customer segment – BtoB

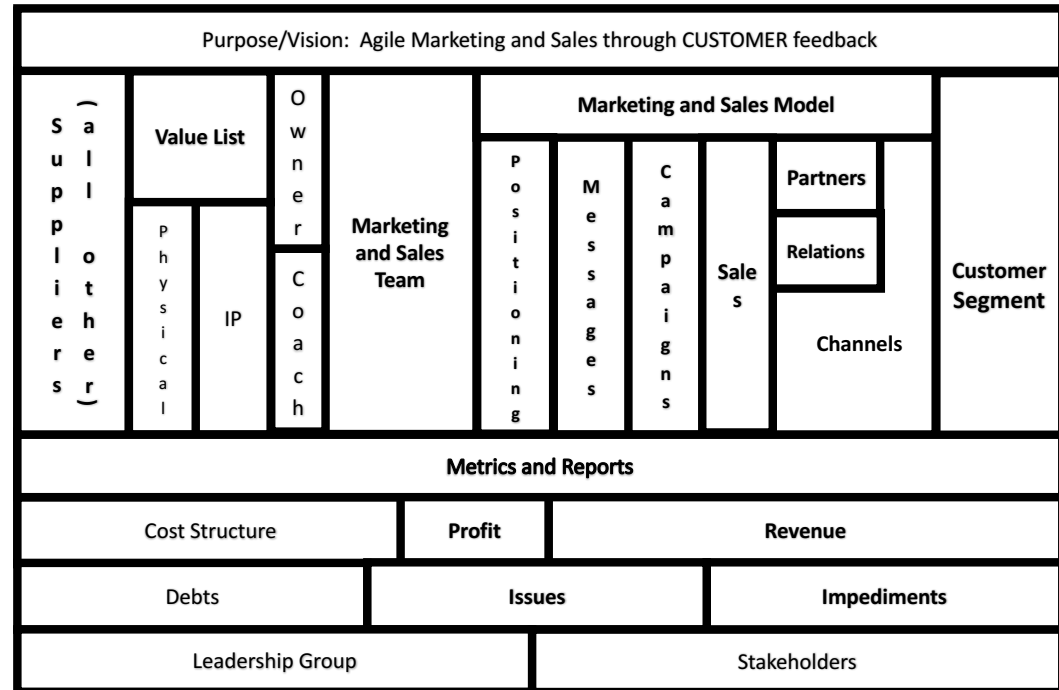
Keep in mind of what Clayton said - the Value Network

Look vertically developing the products for this BtoB Customers [www.AhaAutonomy.com](http://www.AhaAutonomy.com)

[Back](#)

# Marketing and Sales Team

## ES – Marketing and Sales



February 10, 2018

Copyright Enterprise Scrum Inc. DO NOT REPRODUCE WITHOUT PERMISSION.

Different from the product teams

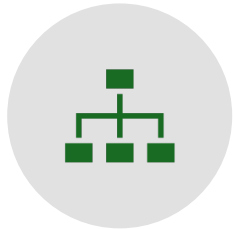
Visualize the key items needed for Marketing & Sales for BtoB

9/27/23

[www.AhaAutonomy.com](http://www.AhaAutonomy.com)

[Back](#)

# Robotic/Subsumption Architecture in ES – Sensors & Actuators – Surfers & Andon

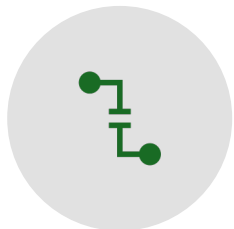


How to divide into subgroups so that the higher layers subsume the lower layer  
**Autonomy on its own layer; Hierarchy of Layers**

**ES – By Customer Segment**



Learning from past behaviors – ES is based on Scrum; Transparency through Canvases, Inspect & Adapt –. Just Scrum Board but canvases on every level



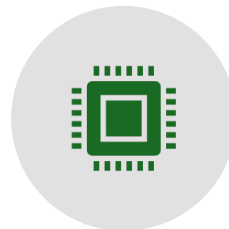
Controlled by Sensors & Actuators

**In ES - Canvases, Surfers**

**All at once Mgmt.**

**Surfers & Andon - Examples from Cihangir;**

More work is needed this area



**No Central Processor**

**Not one person on the top making all the decisions**

---

**Autonomy, Autonomy, Autonomy –** Foundation of Agile

---

All at Once Management via Canvases & Surfers

---

Decentralized Decision Making

---

Faster Time to Market

---

Synergy & Alignment throughout the whole organization

---

Happy teams, customers, stakeholders

---

**Survival & Profits!**

---

# Combine other design frames to develop a design option

- ❖ Geographic – Giving Autonomy to each region or area
- ❖ Value Chain – Designed around a product flow or other value movement (ex – building awareness to buying to implementing, adopting, advocacy)
- ❖ Do Not based on Functional, Develop-deploy, Front and Back as they do not serve customers well

# Would the Subsumption Architecture help with scaling Scrum/Agile?

- ❖ Customer Centered Organization Structure
- ❖ Sensors via **triggers and notifications**
- ❖ Actuators
- ❖ Applying n-level subsumption architecture to the products – not just the org design



**Aha Autonomy**

Want to find out how to start?

Contact us ...

**Sue Ryu**

[Sue.Ryu@AhaAutonomy.com](mailto:Sue.Ryu@AhaAutonomy.com)

[www.AhaAutonomy.com](http://www.AhaAutonomy.com)

<https://www.linkedin.com/in/sueryu/>