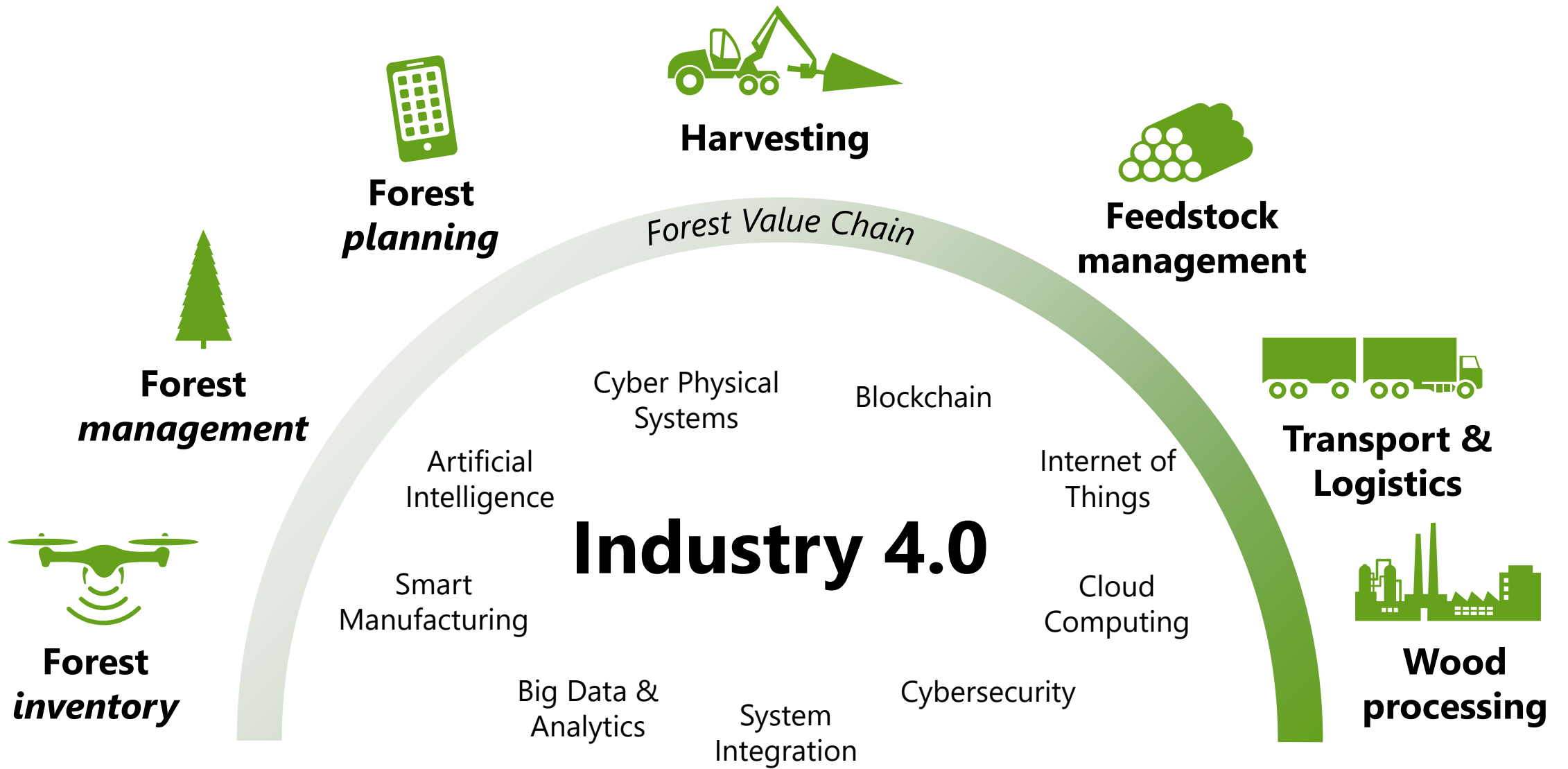**Luke**
NATURAL RESOURCES
INSTITUTE FINLAND

Metsäpäivät | 26.10.2023

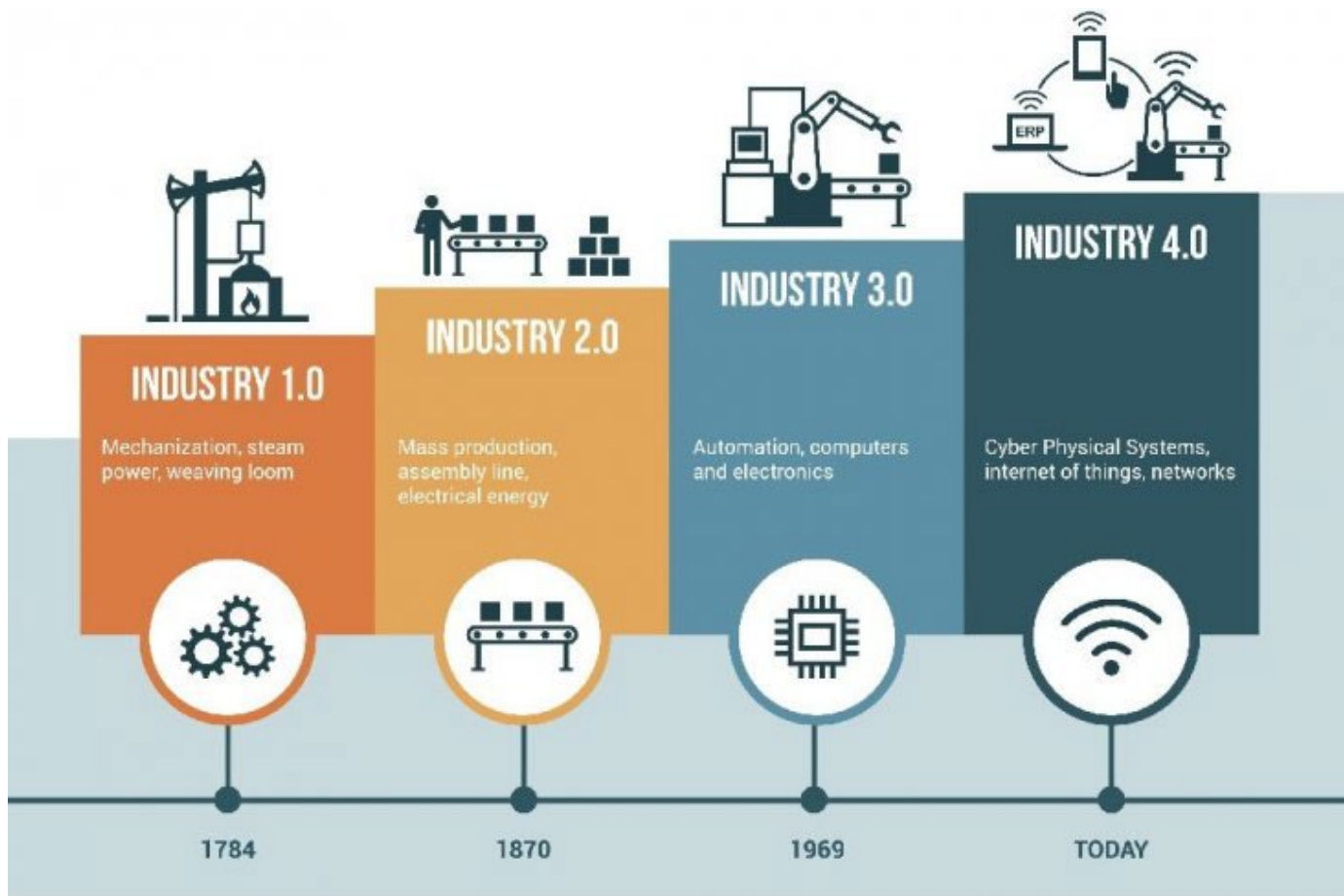# Industry 4.0 for More Sustainable Forest-based Value Chains
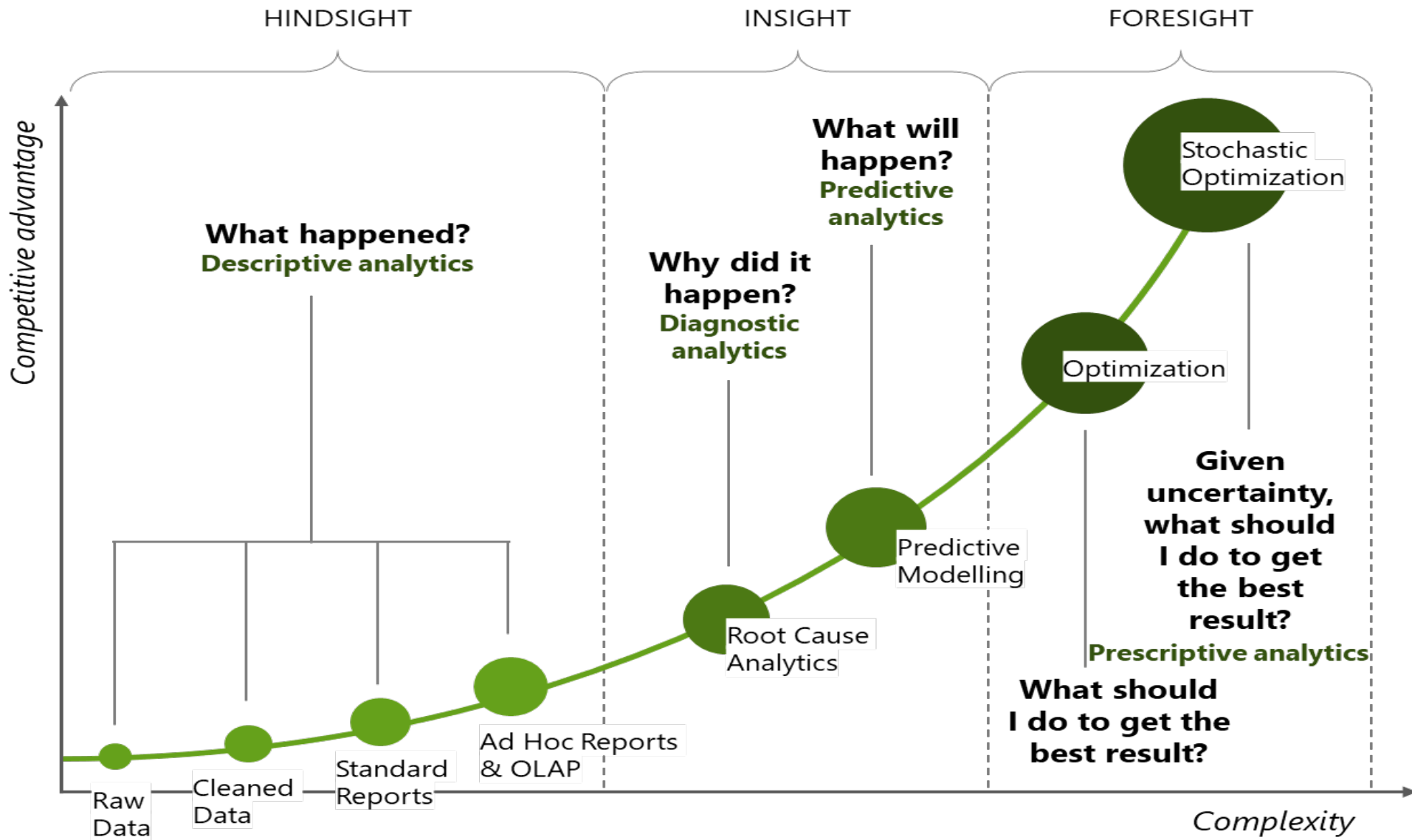
Research Professor Mauricio Acuna

Forest Value Chain

Forest **management**

Forest *planning*

Harvesting

Feedstock management

Transport & Logistics

Forest *inventory*

Wood processing

Cyber Physical Systems

Blockchain

Artificial Intelligence

Internet of Things

Industry 4.0

Smart Manufacturing

Cloud Computing

Big Data & Analytics

System Integration

Cybersecurity

Industry 4.0:
The 4th Industrial Revolution (4IR)

INDUSTRY 1.0
Mechanization, steam power, weaving loom

INDUSTRY 2.0
Mass production, assembly line, electrical energy

INDUSTRY 3.0
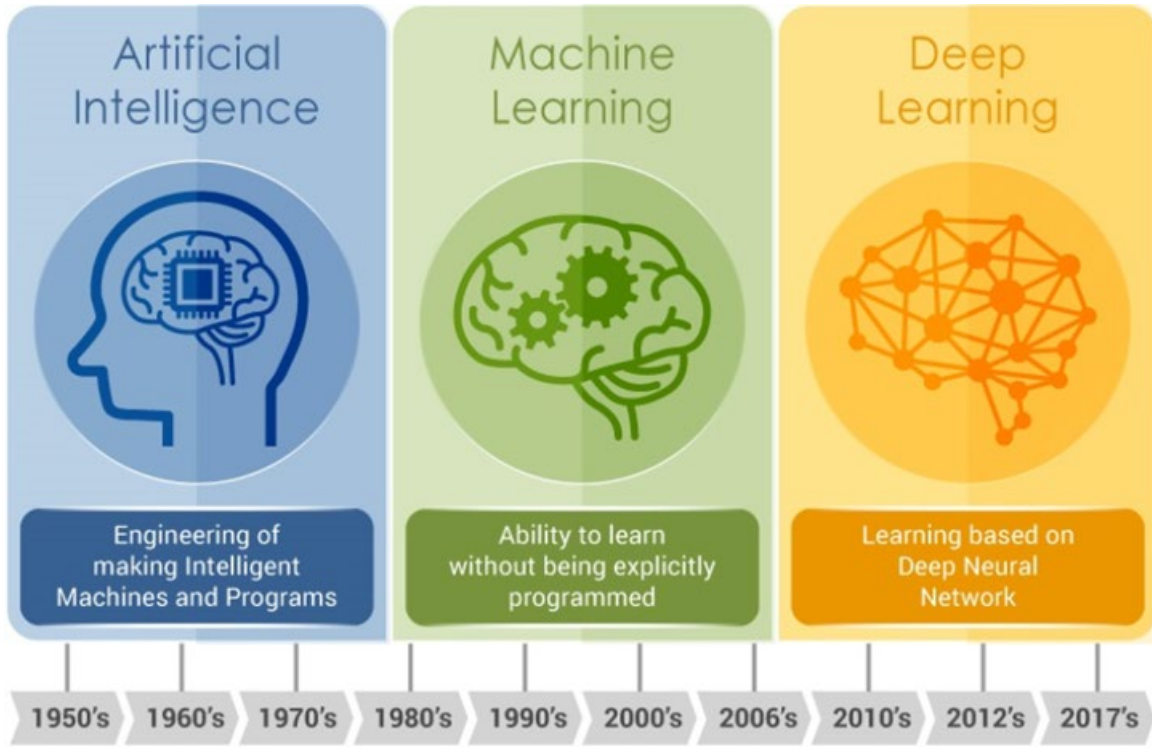Automation, computers and electronics

INDUSTRY 4.0
Cyber Physical Systems, internet of things, networks

1784 · 1870 · 1969 · TODAY

11 Pillars of Technological Advancement

Autonomous Robot
Simulation & Augmented Reality
Horizontal & Vertical Integration
Big Data Analytics
Industrial Internet of Things
Supply Chain
Cybersecurity
Additive Manufacturing
Artificial Intelligence
Cloud
New Business Models

Data Analytics for improved decision making

Luke ©LUONNONVARAKESKUS

HINDSIGHT | INSIGHT | FORESIGHT

Competitive advantage

What happened?
Descriptive analytics

Why did it happen?
Diagnostic analytics

What will happen?
Predictive analytics

Stochastic Optimization

Optimization

Predictive Modelling

Root Cause Analytics

Ad Hoc Reports & OLAP

Standard Reports

Cleaned Data

Raw Data

Given uncertainty, what should I do to get the best result?
Prescriptive analytics

What should I do to get the best result?

Complexity

Modified | Original source: McDonald (2016)

Analytics | Human input

Data

Descriptive
What happened?

Diagnostic
Why did it happen?

Predictive
What will happen?

Prescriptive
What should I do?

Decision support

Decision automation

Decision

Action

Source: https://datajourney.akvo.org

Artificial Intelligence (AI),
Machine Learning (ML),
Deep Learning (DL)
for improved decision making

Luke ©LUONNONVARAKESKUS

Artificial Intelligence — Engineering of making Intelligent Machines and Programs

Machine Learning — Ability to learn without being explicitly programmed

Deep Learning — Learning based on Deep Neural Network

1950's 1960's 1970's 1980's 1990's 2000's 2006's 2010's 2012's 2017's
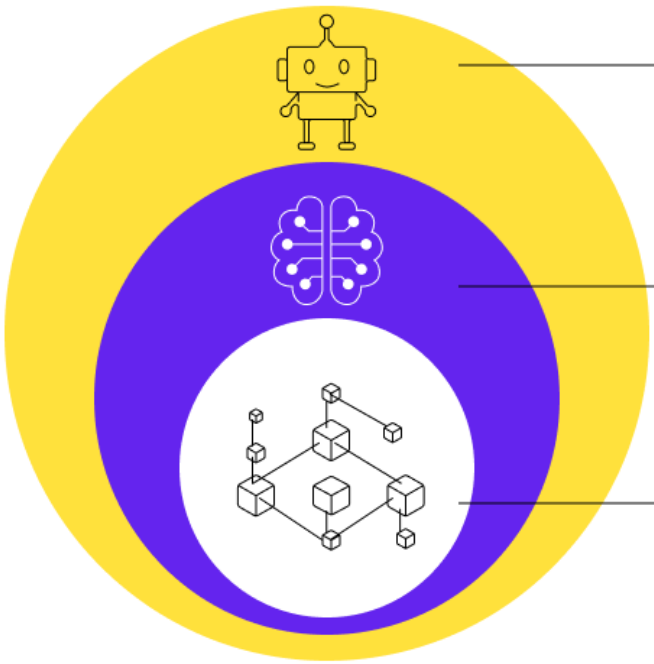
Artificial Intelligence
Computers that can imitate human intellect and behavior.

Machine Learning
Statistical algorithms that enable AI implementation through data.

Deep Learning
Subset of machine learning which follows neural networking.

Source: Mentalstack

**Why 4IR Techs
(Optimization, Automation, AI)
in forest-based value chains?**

- To address labor issues and increase safety *(social aspect)*

- To boost productivity and reduce costs *(economic aspect)*

- To mitigate the impact on flora, fauna, water courses, and soil *(environmental aspect)*

- To get immediate access to digital data for informed decision-making *(competitive aspect)*

- To promote resilience and sustainability throughout business and supply chains *(sustainability aspect)*

Barriers to AI adoption

The top 5 barriers to AI adoption (Forbes)

1. Initial investment
2. Cultural barriers
3. Fear
4. Shortage of talent
5. Lack of strategic approach

Top 3 challenges to AI/ML adoption
Sum of 1 to 3 rank

Enterprise maturity

Skills of staff	56%
Data scope or quality	34%
Governance issues or concerns	13%

Fear of unknown

Understanding AI benefits and uses	42%
Security or privacy concerns	20%
Measuring the value	17%
Risk or liabilities	6%

Finding a starting point

Finding use cases	26%
Defining the strategy	25%
Finding funding	12%

Vendor strategy

Integration complexity	26%
Confusion over vendor capabilities	10%

gartner.com/SmarterWithGartner

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Gartner.

4IR Applications

Luke

4IR Application: Wood supply chain optimization

FastPLAN

MCPLAN

FastTRUCK

Harvest Plan - Tactical

Harvest Plan - Operational
Transport tasks

Uncertainty level

Annual

Monthly

Weekly/Daily

Decision Timing
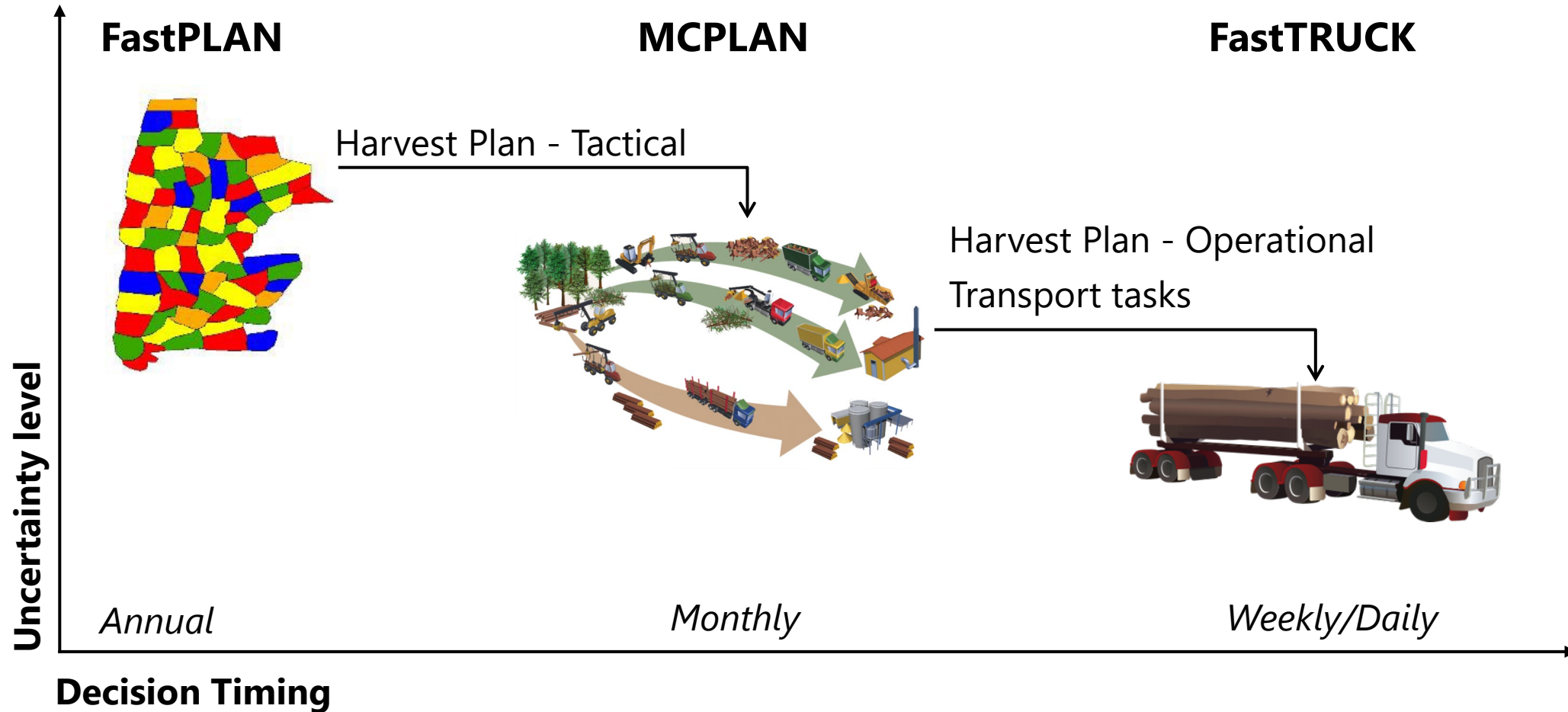
4IR Application: Emerging and disruptive technologies

How a drone tractor works

The Properties of Distributed Ledger Technology (DLT)

4IR Application: Automated volumetric measurements
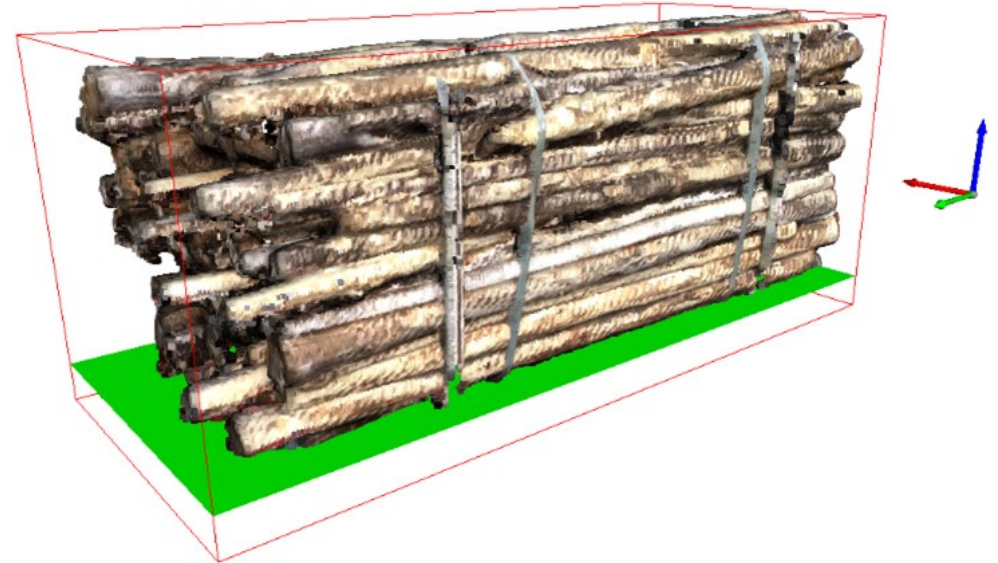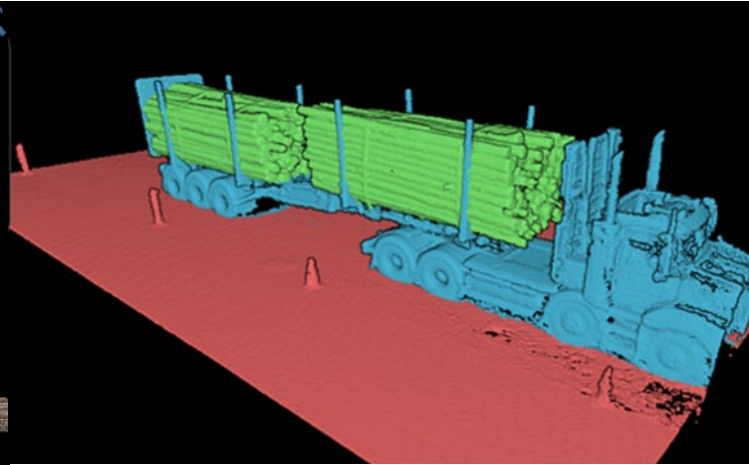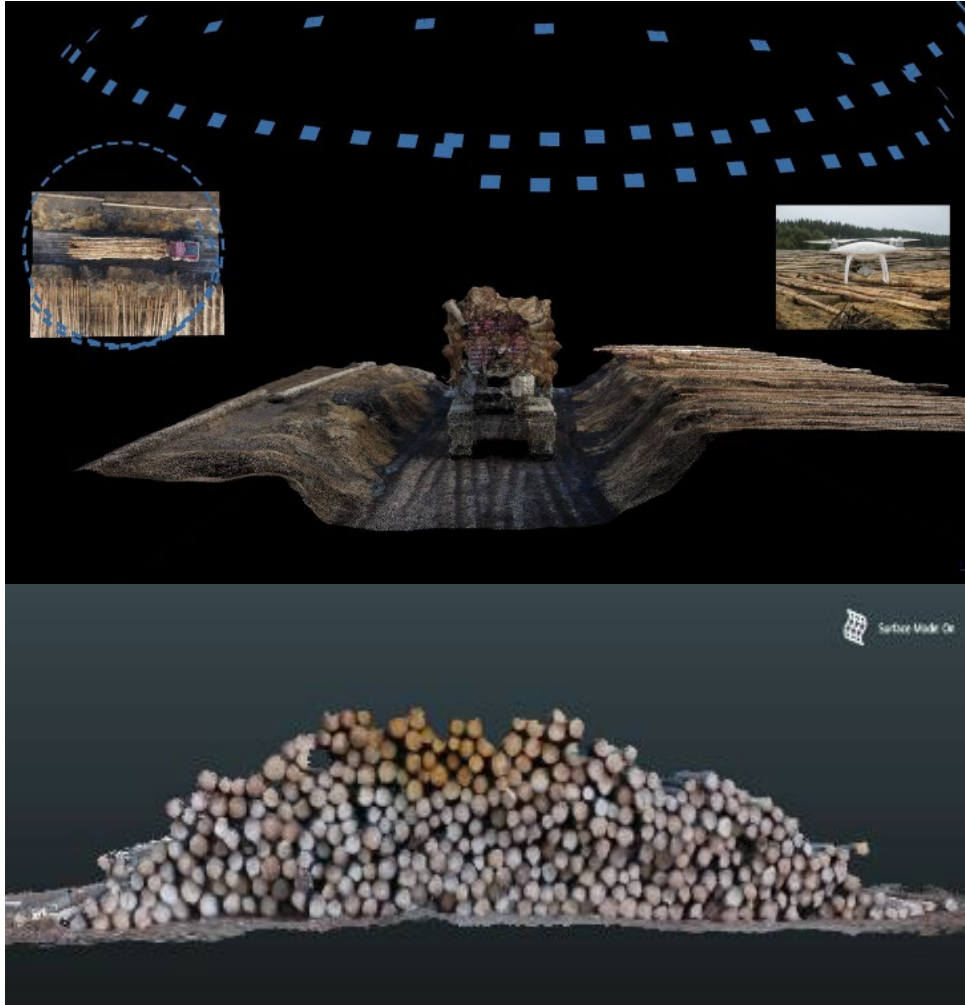
4IR Application: Sensors on harvesting equipment
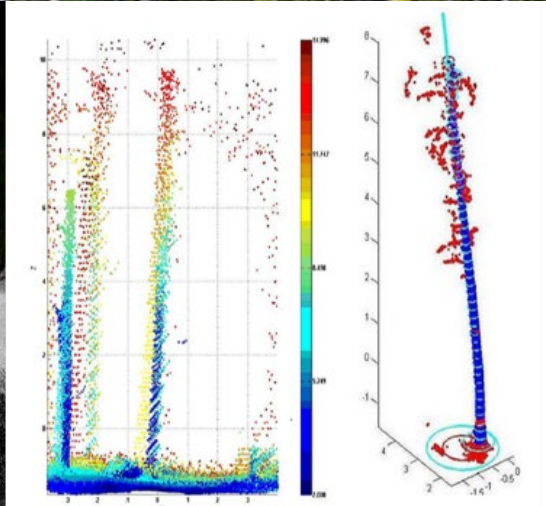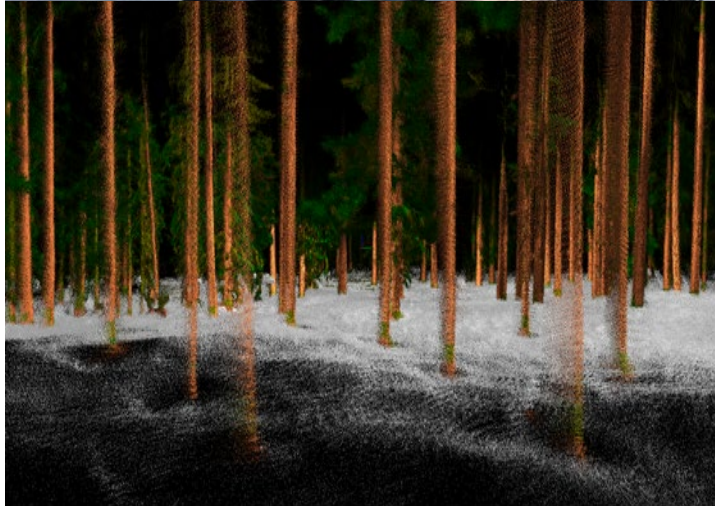
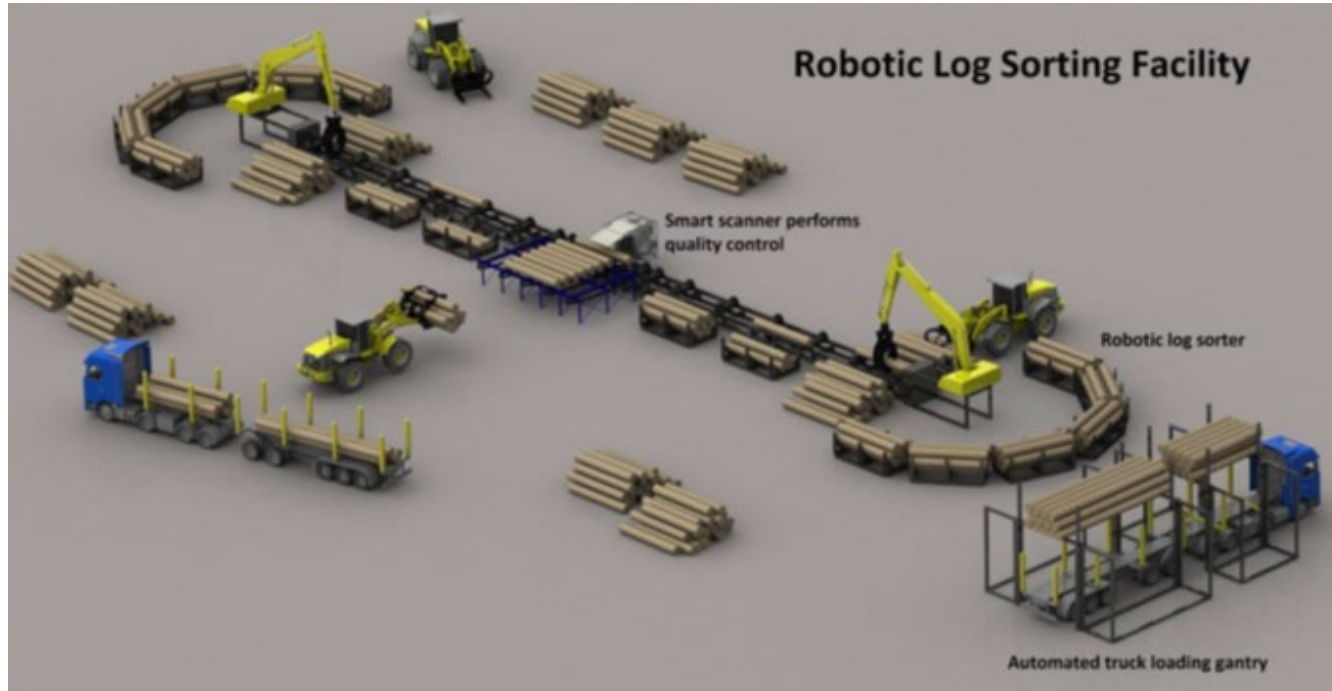# 4IR Application: Robotic systems

Robotic Log Sorting Facility

Smart scanner performs quality control

Robotic log sorter

Automated truck loading gantry

Body Panels

Grapple Claws

Harvester Head

Swivel Joints

Flexible Rubber

Arm Extension

Impact Friendly Tires

Source: Visser & Obi (2016)

Take away messages

- **Consider how Industry 4.0 technologies can enhance your business**; establish a clear objective and roadmap (strategic approach)

- **Prepare your company and personnel for adopting 4IR technologies** (identify and address potential barriers to adoption)

- **You cannot manage what you don't measure**, so begin by collecting data, as effective management starts with measurement

- Leverage machine data to its fullest potential by utilizing **data analytics** and **machine learning** to identify inefficiencies, bottlenecks, and utilization patterns

- **Enhance decision-making** for sustainable and competitive forest operations, encompassing economic, environmental, and social aspects

- Champion a culture of **continuous improvement** within your company

- **Cultivate collaborations** with fellow entrepreneurs, technology firms, machinery manufacturers, universities, and research institutions (e.g., Luke) to stay at the forefront of 4IR advancements.

Thanks for your attention

mauricio.acuna@luke.fi