



**Pacific
Northwest**
NATIONAL LABORATORY

Digitalization Strategy & Roadmap - Use Cases

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Collaborative Workshop
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NREL

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U.S. DEPARTMENT OF
ENERGY **BATTELLE**

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Definition- 4Ds

Digitalization¹ is “the use of digital technologies to change a business model and provide new revenue and value-producing opportunities.

Digitalization² can be thought of as the increasing interaction between the digital and physical worlds. The digital world has three fundamental elements:

- **Data:** digital information. Data creation often requires low-cost sensing provided by IoT.
- **Analytics:** the use of data to produce useful information and insights. Often uses Artificial Intelligence.
- **Connectivity:** Exchange of data between humans, devices, and machines (including machine-2-machine) through digital communication and networks such as 5G.

Digital Twin (DT)^{3,4}: is the combination and virtual representation of a coupled computational model and a real-world system, designed to monitor, control and optimize its functionality. Through data and feedback, both virtualized and real, a digital twin can develop capacities for autonomy and to learn from and reason about its environment. DT is one of the key manifestations of Digitalization Technology. A digital twin can be defined, fundamentally, as an evolving digital profile of the historical and current behavior of a physical object or process that helps optimize plant performance.

Digital Discovery: Is intended to discover a new process, material, or a product utilizing both digital twin and digital thread. The primary motivation for digital discovery is innovation.

Digital Thread⁵: Refers to the communication framework that allows a connected data flow and integrated view of the asset’s or products or process data throughout its lifecycle across traditionally siloed functional perspectives. The digital thread concept raises the bar for delivering “the right information to the right place at the right time.”

1. <https://www.gartner.com/en/information-technology/glossary/digitalization>
2. <http://www.iea.org/publications/freepublications/publication/DigitalizationandEnergy3.pdf>
3. <file:///C:/Users/ahme762/Projects/Digitalization/Hydropower/Digital%20twin%20report.pdf>
4. <deloitte-cn-cip-industry-4-0-digital-twin-technology-en-171215.pdf>
5. <https://www.industryweek.com/technology-and-iiot/systems-integration/article/22007865/demystifying-the-digital-thread-and-digital-twin-concepts>

The World of Digitalization- Past

The question yesterday was market penetration

McKinsey Global Institute industry digitization index; 2015 or latest available data

Relatively low digitization  Relatively high digitization

● Digital leaders within relatively undigitized sectors

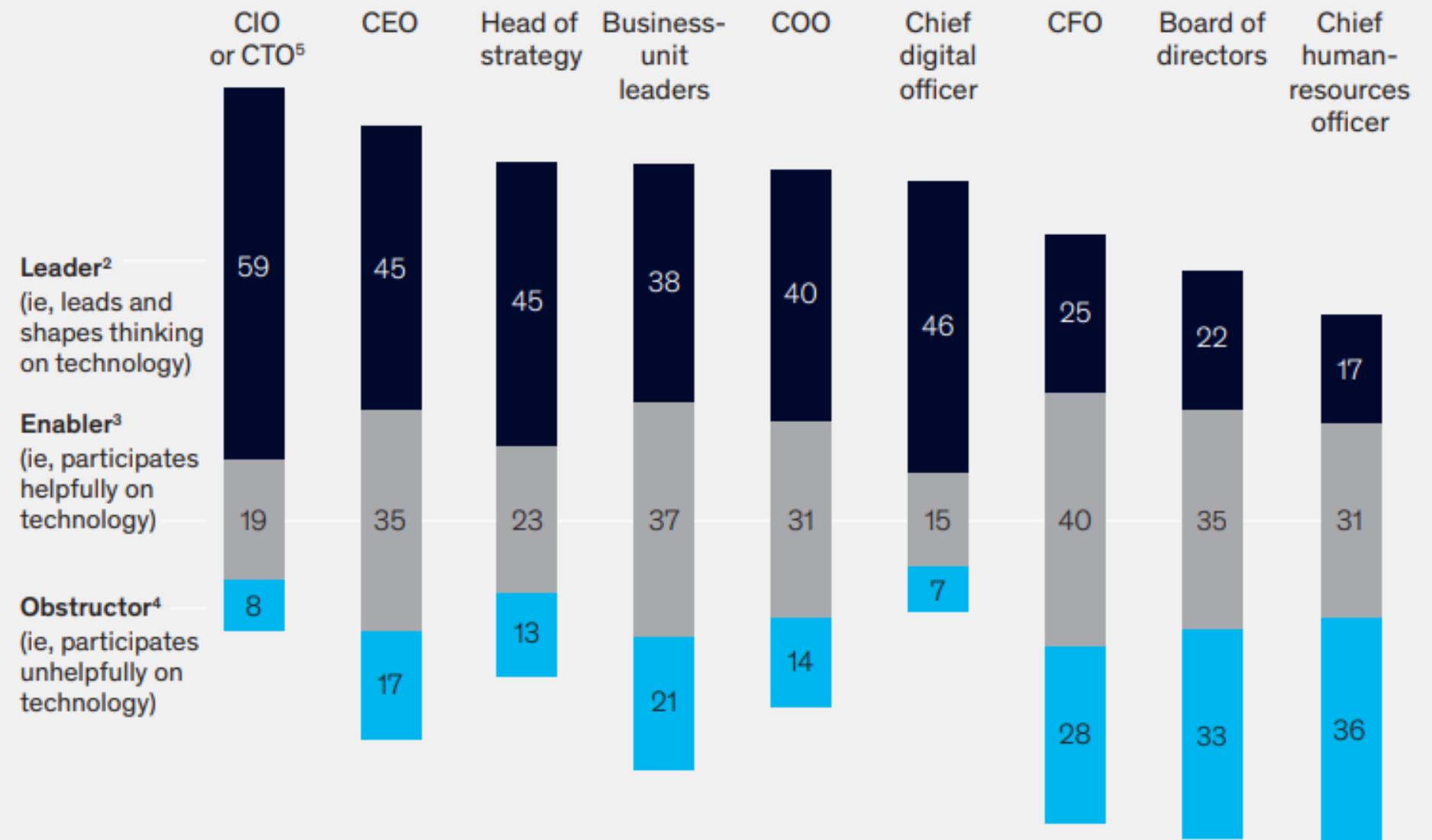


The World of Digitalization- Present

Focus today is engagement and implementation

Across the leadership team, the call to become more tech savvy is urgent—even for roles that have typically engaged very little with technology.

Level of engagement, by role, % of respondents¹



<https://www.mckinsey.com/~media/mckinsey/featured%20insights/mckinsey%20global%20surveys/mckinsey-global-surveys-2021-a-year-in-review.pdf>

Digitalization and the future of energy

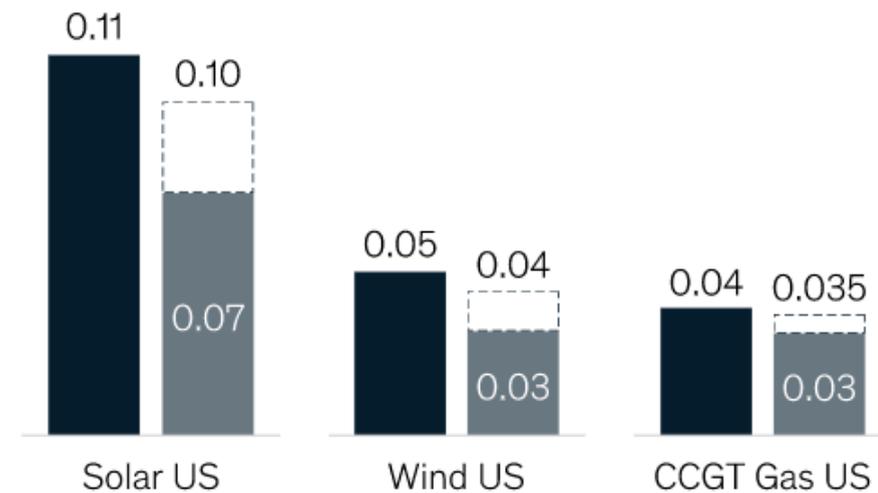
Case study at McKinsey- a global Business Consulting Company

Done right and at scale, digital will materially affect competitiveness.

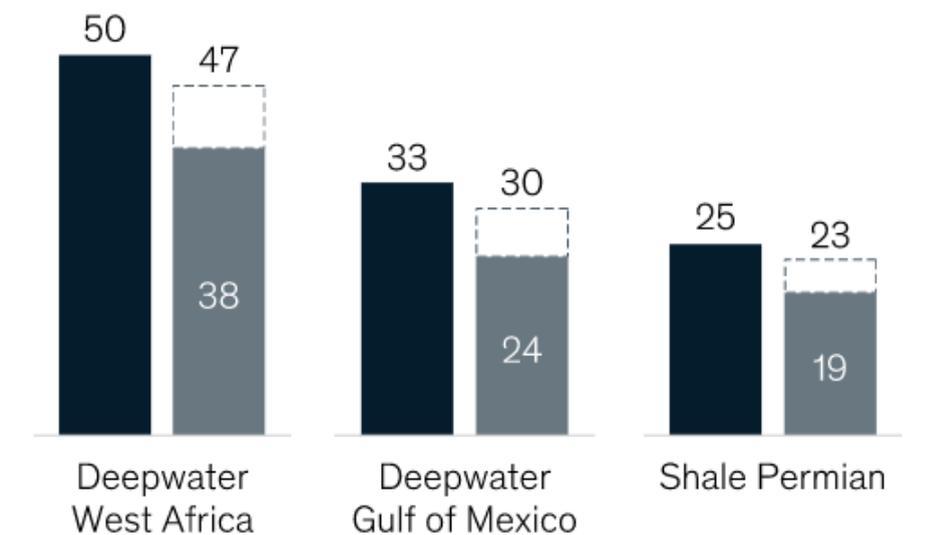
Narrow efforts at digital have shown ~2 to 10 percent yield improvements and ~10 to 30 percent cost improvements in capital, supply chain, and operations. **What is the cost efficiency opportunity if these impacts hold at scale?**

Illustrations of potential impact

Power,¹ \$/KWh



Oil and gas upstream,² \$/boe



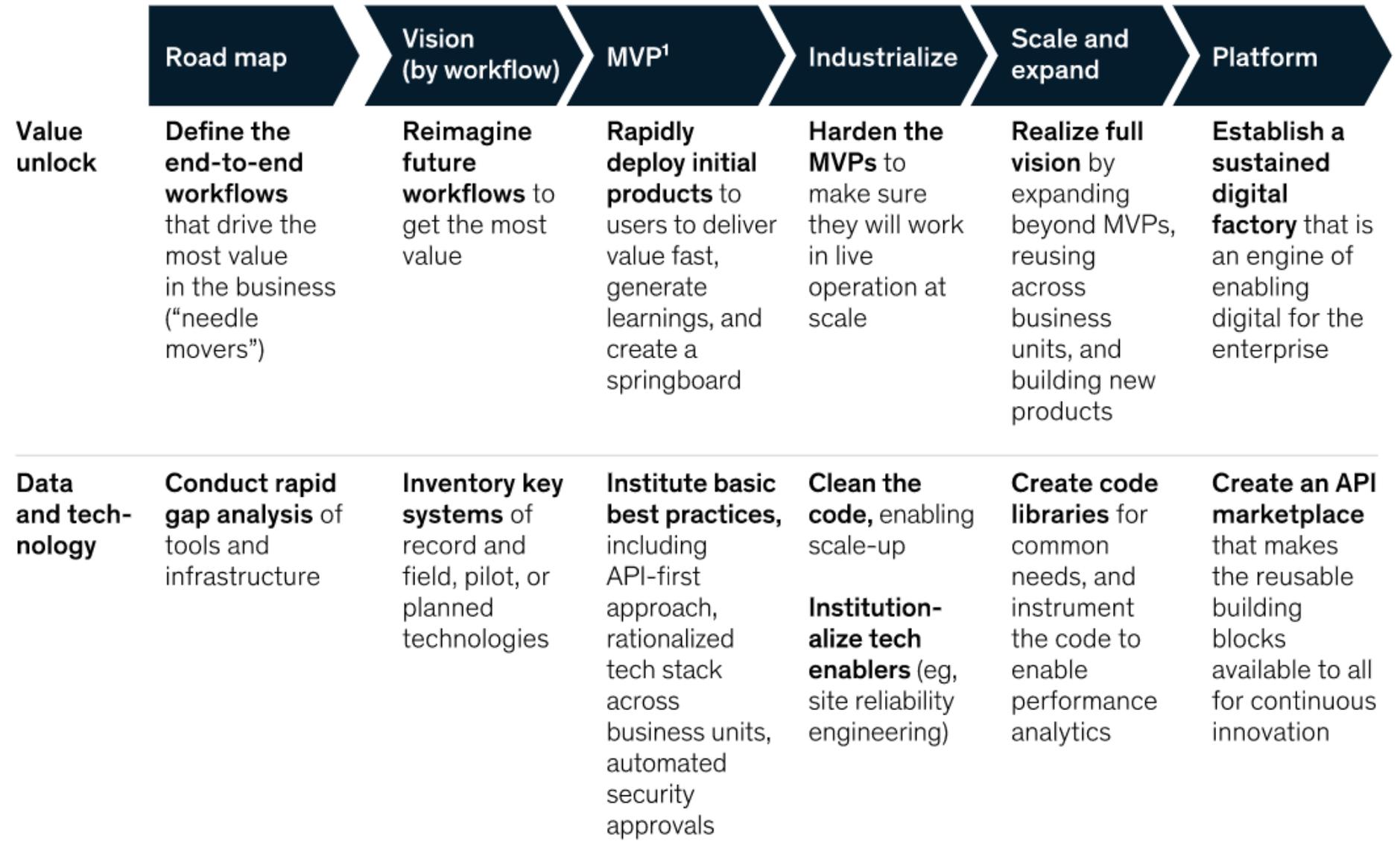
<https://www.mckinsey.com/industries/oil-and-gas/our-insights/digital-transformation-in-energy-achieving-escape-velocity>

Digitalization and the future of energy

Case study at McKinsey- a global Business Consulting Company

Digital transformation in energy: Achieving escape velocity

Value-focused vision within weeks; value and action within first 6 months; transformation in 18–24 months



Digitalization and the future of energy

Case study at McKinsey- a global Business Consulting Company

Value-focused vision within weeks; value and action within first 6 months; transformation in 18–24 months



Culture and capabilities	Conduct rapid gap analysis of digital and nondigital capabilities	Engage the most courageous, informed, creative leaders to own and shape the vision	Catalyze frontline buy-in from business units and create a forcing mechanism to simplify IT policies	Establish user support process and capabilities to ensure manageable scale-up	Demonstrate the value of sharing, standardization, and scale Expand in-house talent base	Formalize the digital factory's operating model and replicate it
Time-frame	4–12 weeks	4–12 weeks	8–12 weeks	4–6 weeks	2–8 weeks for reuse; expansions span 12–18 months	After 12–18 months

Digitalization Strategy Suggested by Deloitte

Assess external and internal situation:

- Analyze external forces and trends*
- Identify and prioritize customers' and other stakeholders' needs and wants.*
- Analyze digital technologies suitable for enhancing customer experience.*
- Analyze current business & operating model*
- Analyze people and cultural potential for changes*
- Map and cross-map core & extended architectural domains*

Design/Architect business solution:

- Visualize to-be business architecture*
- Develop to-be people practices & organizational culture.*
- Design to-be organization structure*
- Design to-be value chain & processes*
- Visualize to-be IT architecture*
- Analyze current state/target state transformation*

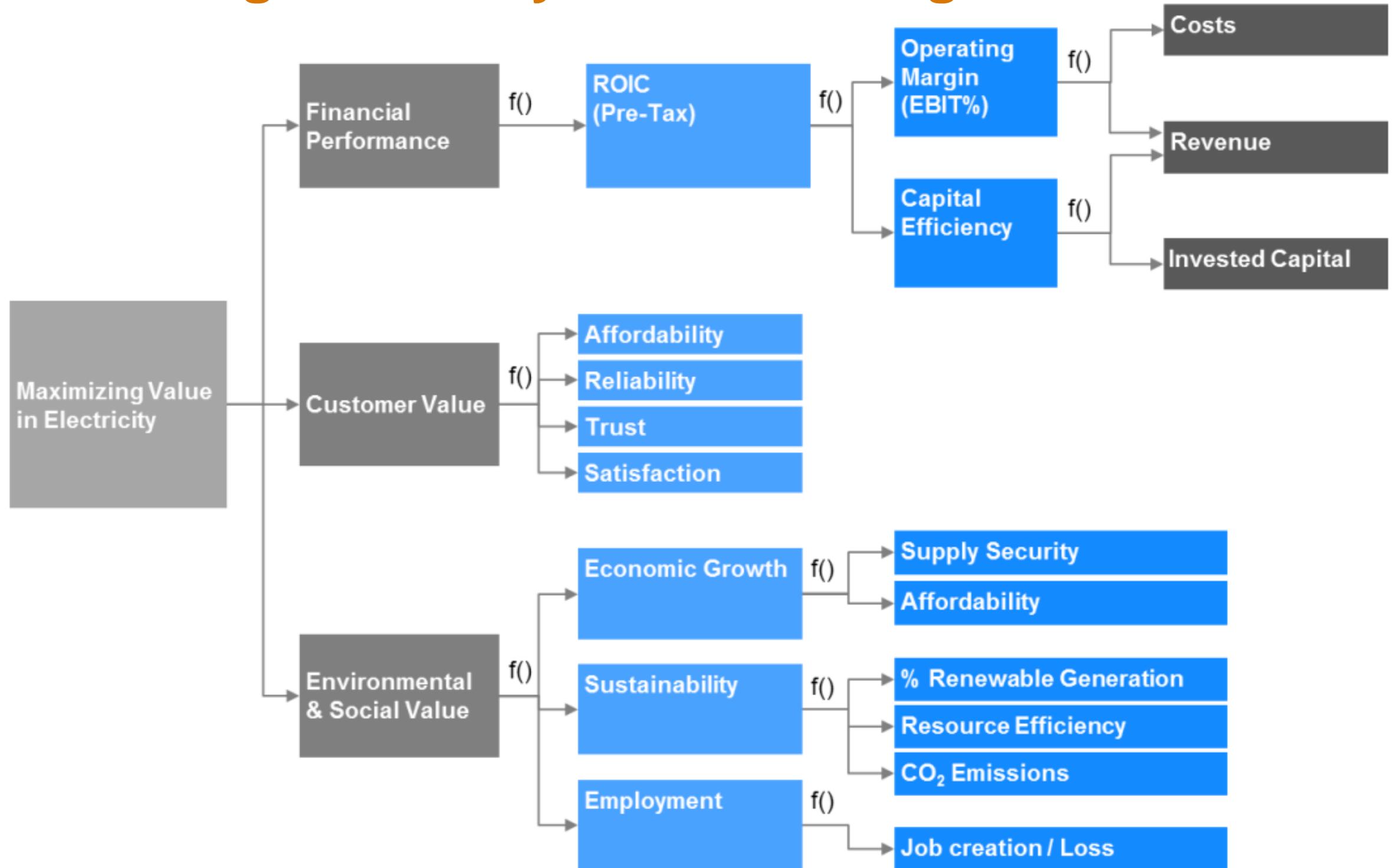
Develop strategy and assess business impacts:

- Define different business scenarios*
- Define target customer segments and technologies to be used*
- Develop to-be business model.*
- Develop goal/objective hierarchy*
- Analyze business architecture/IT architecture impact*

Establish initiatives and deploy solution

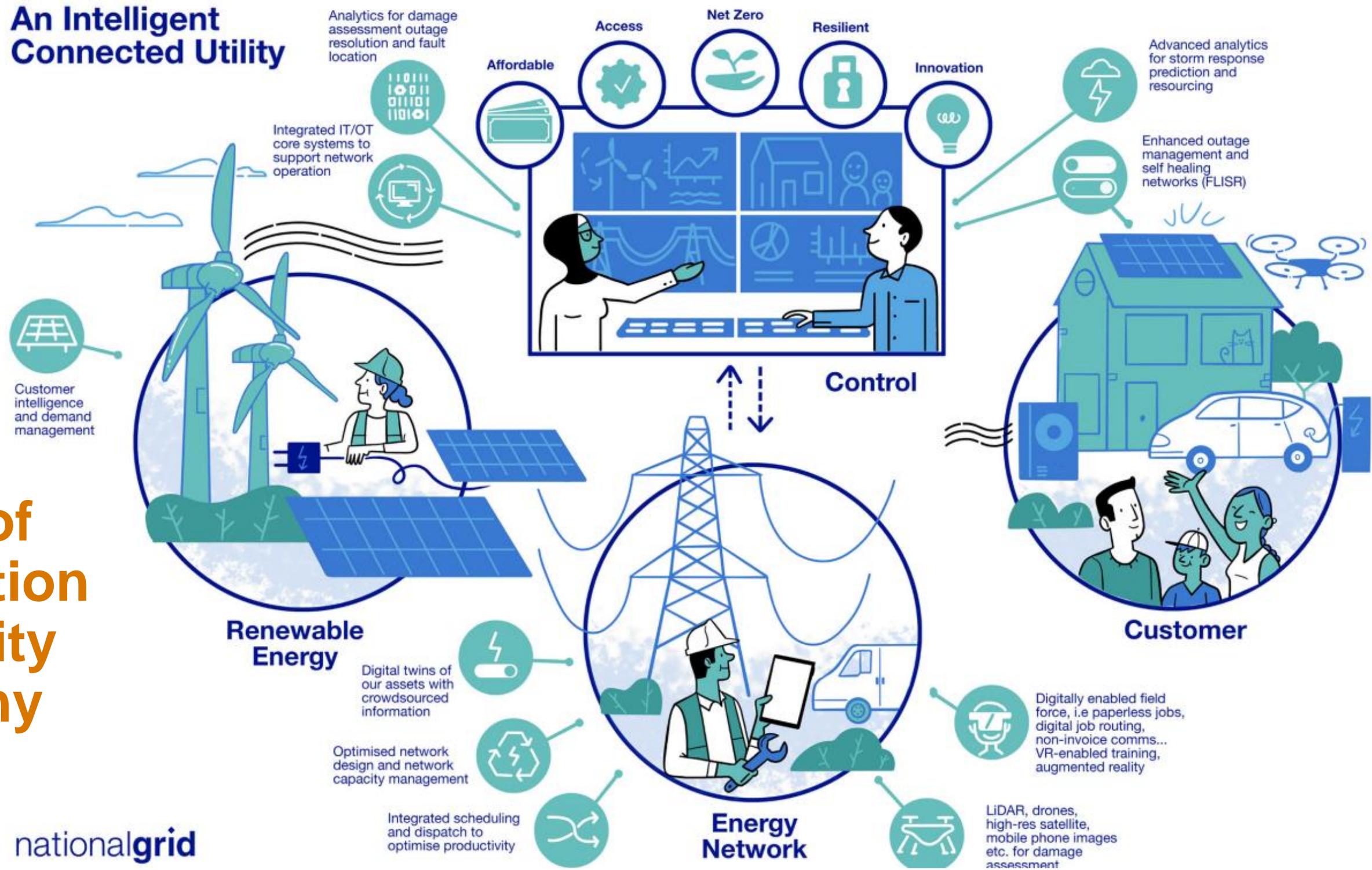
- Define initiatives based on the objectives*
- Prioritize initiatives*
- Create initiative measurement criteria & KPIs*
- Establish project plan.*
- Monitor progress & deploy corrective measures*
- Evaluate the level of success*

Maximizing Electricity Value thru Digitalization



Source: Accenture analysis for the Digital Transformation of Industries project

An Intelligent Connected Utility



Vision of Digitalization by a Utility Company

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Case study at DNV- a global risk management company



<https://www.dnv.com/power-renewables/themes/digitalization/index.html#>



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DIGITIZATION → Making things digital

The process of changing from analogue to digital form, also known as digital enablement. Said another way, digitization takes an analogue process and changes it to a digital form without any different-in-kind changes to the process itself.

DIGITALIZATION → Business opportunities created by digitization

The use of digital technologies to change a business process and enhance efficiency and revenue; it is the process of moving to a digital business.

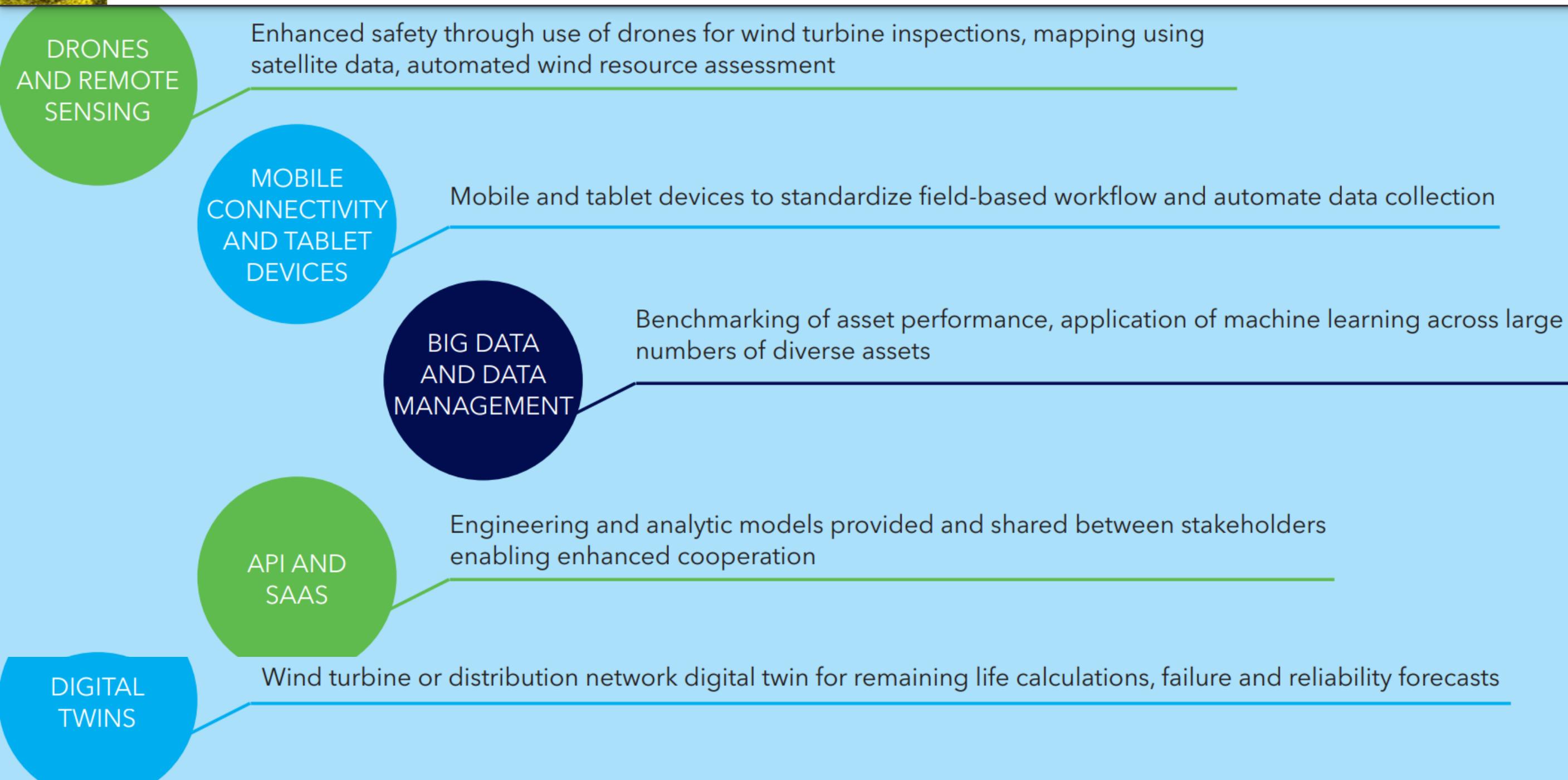
DIGITAL TRANSFORMATION → Changing business models with digitalization

The use of digital technologies to change a business model and provide new revenue and value-producing opportunities.



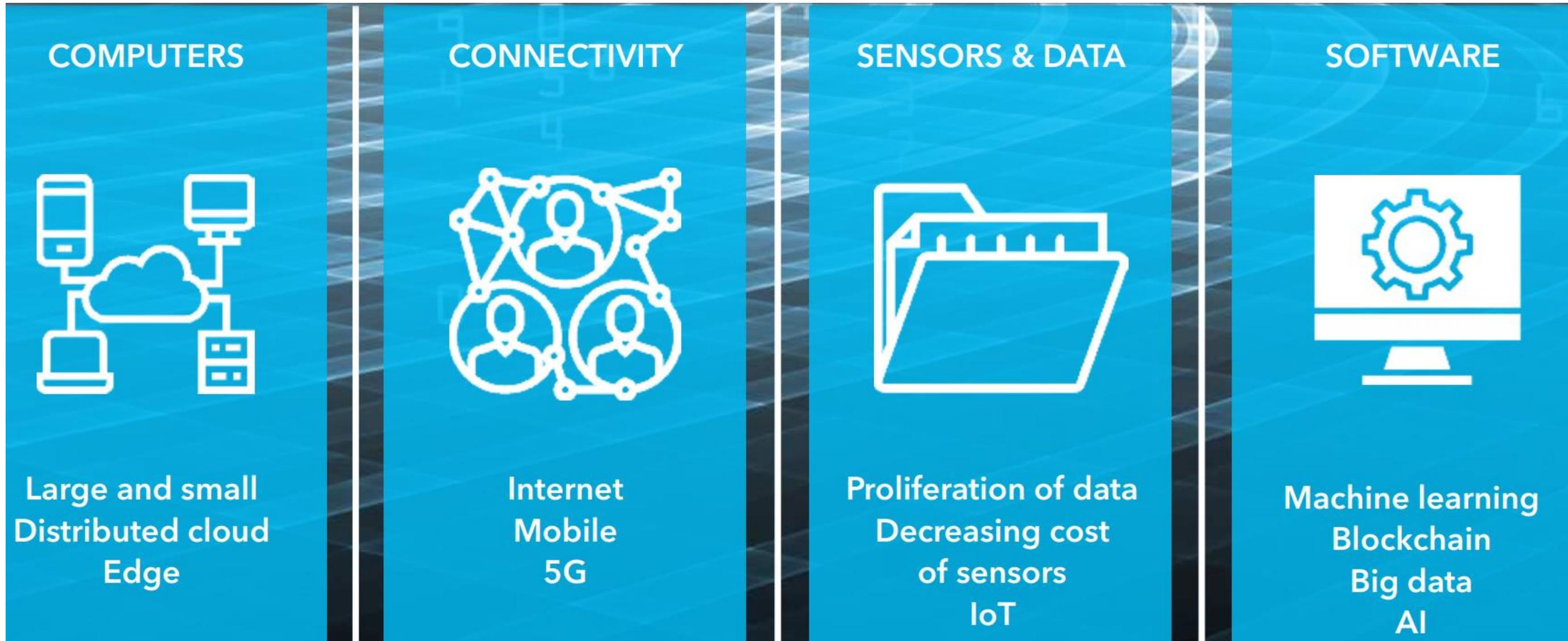
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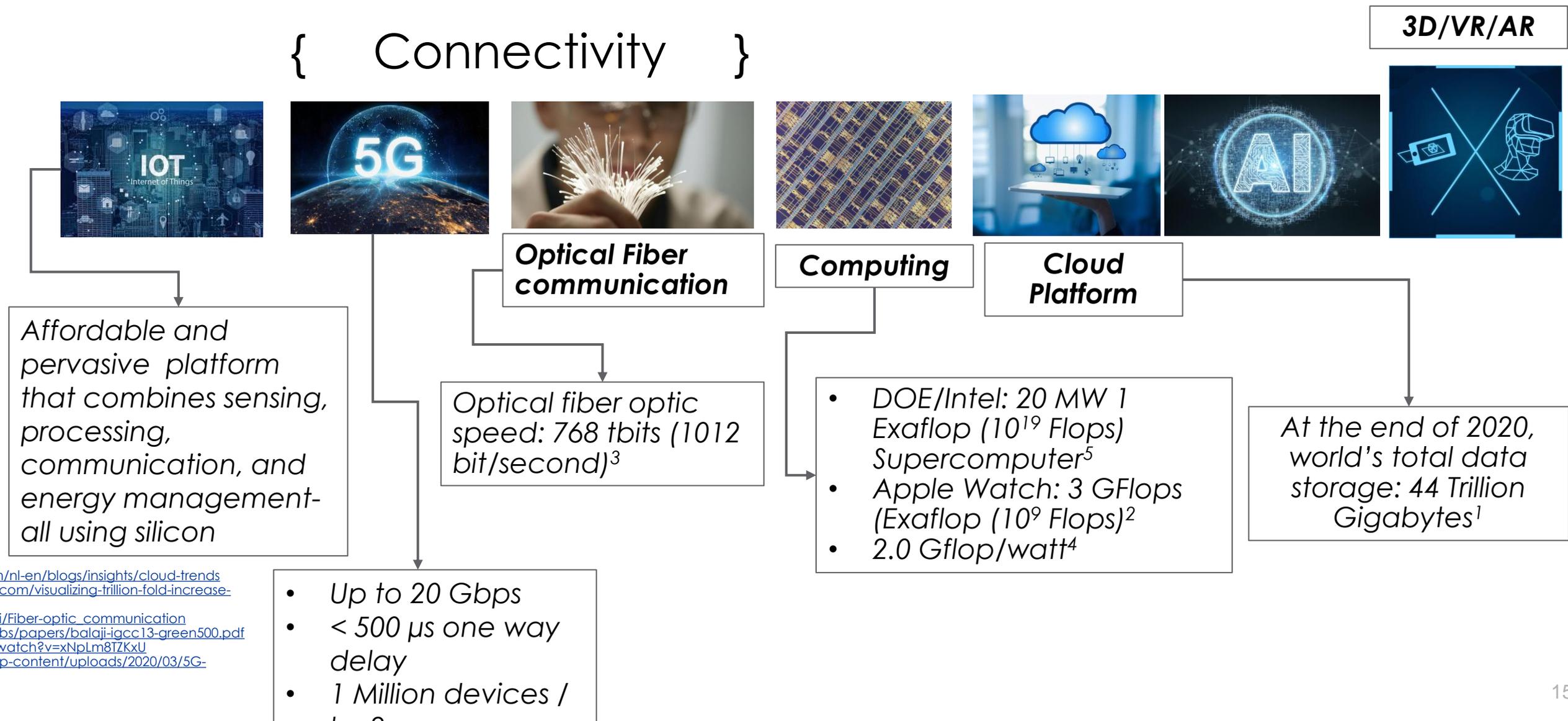


Technology Drivers

Key Digitalization Enabling Technologies:

Technologies that are focused on:

1. Data creation, transfer, storage, and processing
2. Extraction of insight and presentation
3. Creating value-added solutions



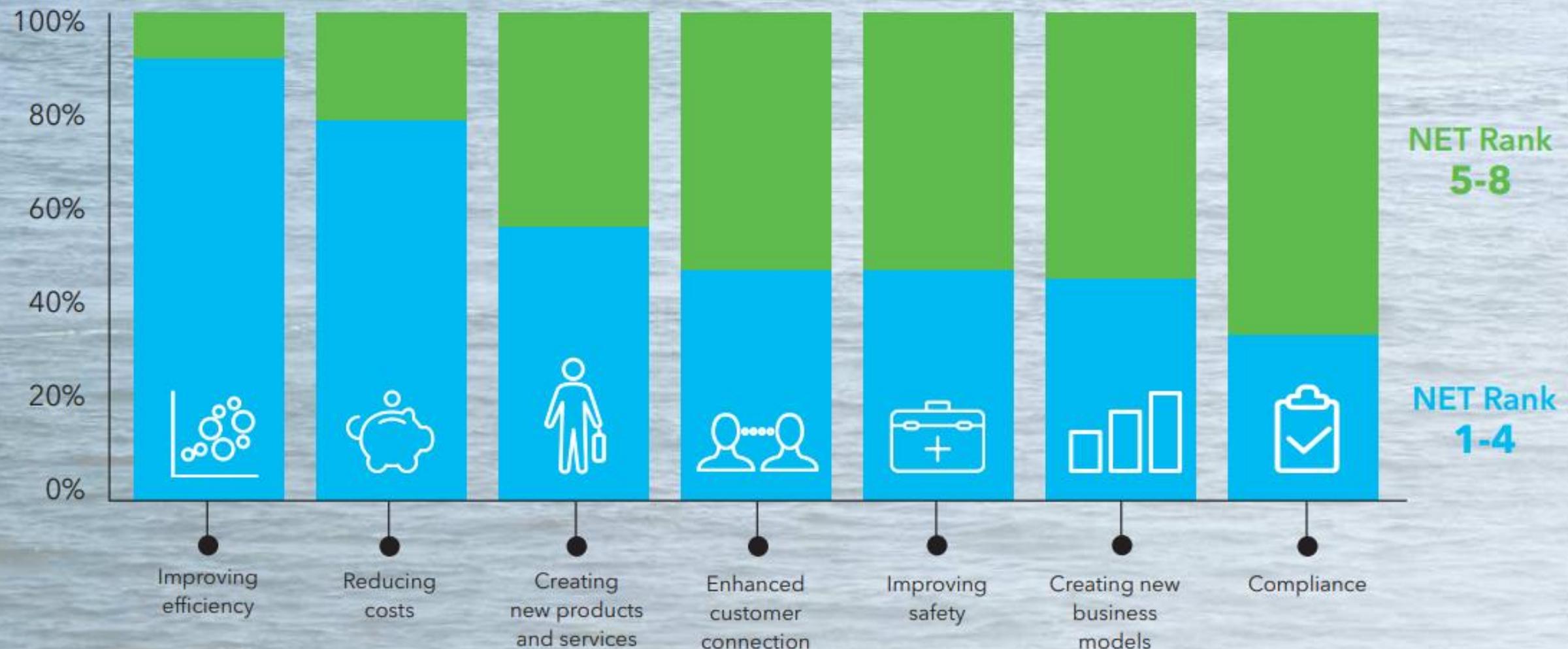
1. <https://www.accenture.com/nl-en/blogs/insights/cloud-trends>
 2. <https://www.visualcapitalist.com/visualizing-trillion-fold-increase-computing-power/>
 3. https://en.wikipedia.org/wiki/Fiber-optic_communication
 4. <https://synergy.cs.vt.edu/pubs/papers/balaji-igcc13-green500.pdf>
 5. <https://www.youtube.com/watch?v=xNpLm8TZKxU>
 6. https://www.isemag.com/wp-content/uploads/2020/03/5G-RAN_Ensuring-KPIs.pdf

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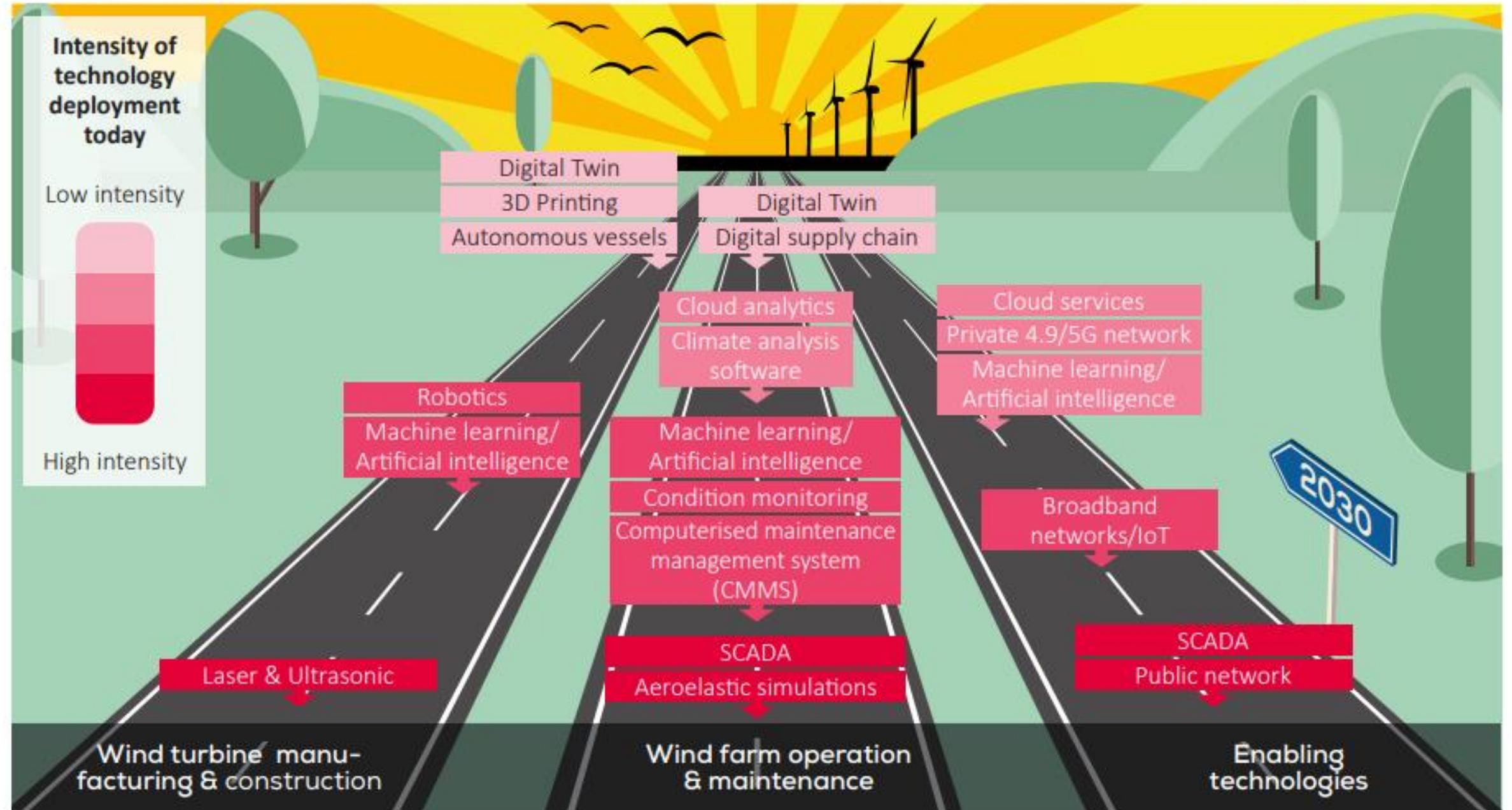
Efficiency and cost are main goals of digitalization

What are your organization's main goals regarding their digitalization strategy? Ranked in order of priority



Digitalization Strategy for Wind Energy in Europe

Roadmap towards a digital wind sector by 2030 and the application intensity of digital technologies today



Wind energy digitalisation towards 2030:
www.windeurope.org

Picture of the Future

A Part of Long-term Strategy Planning Using Retropolation and Extrapolation

Reference: Book by Siemens

<https://www.amazon.com/Using-Trends-Scenarios-Strategy-Development/dp/3895783048>. Published in ~2008



Niels Bohr, the recipient of the Nobel Prize for Physics in the year 1922, once quipped, “Prediction is hard, especially if it’s about the future.”

Past predicting present



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Figure 65 After a visit to the opera at night in Paris in the year 2000: from the perspective of the year 1902 (Albert Robida, Source: Bridgeman Art Library)

Past predicting present



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*Proudly Operated by **Battelle** Since 1965*

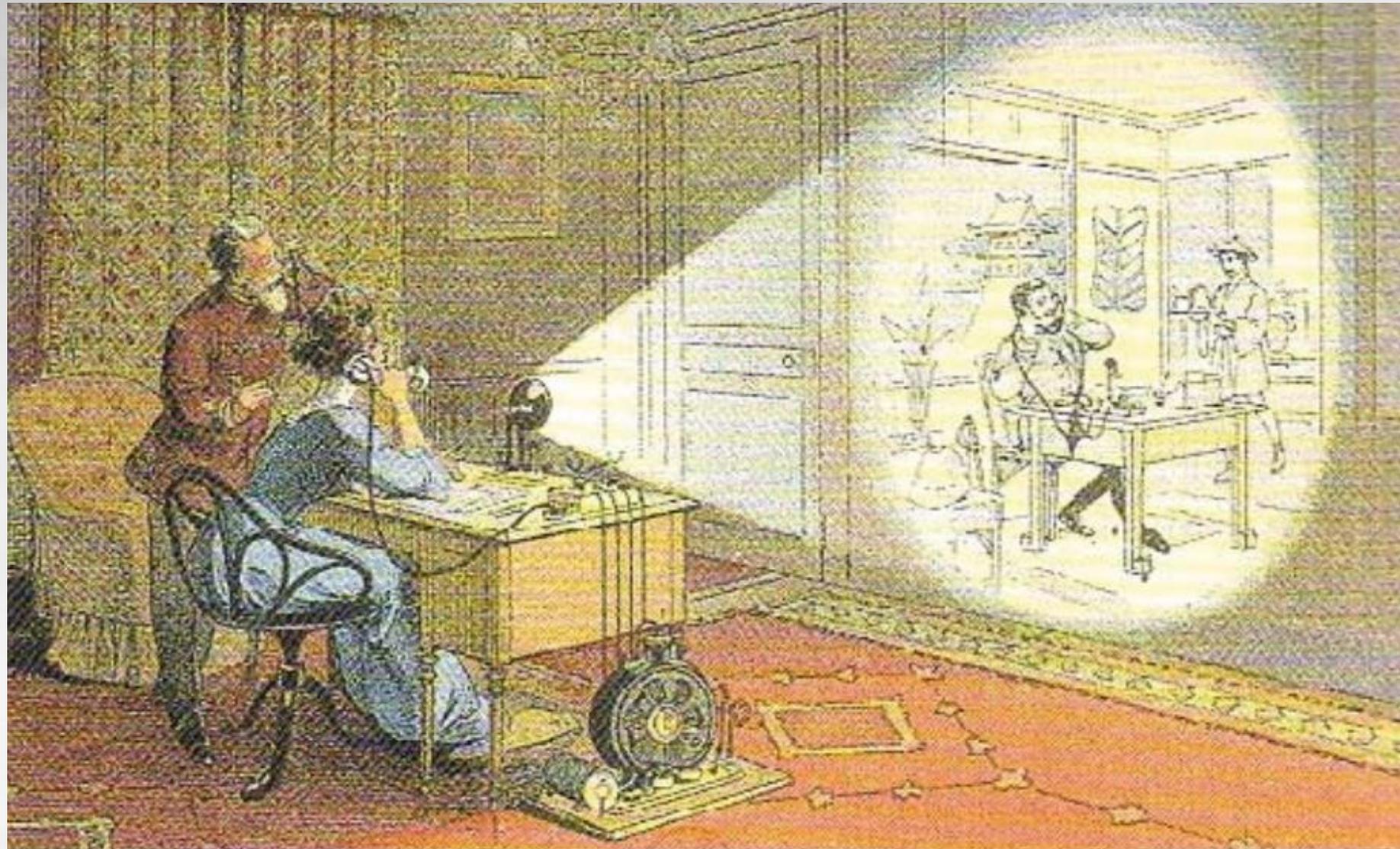


Figure 66 In the year 2000 people will use the video-telephone: vision from the year 1912



Scenario 2060: A Landscape for Tomorrow's Children

Scenario 2060: A former state premier is hiking with her grandson through the Alpine foothills. They are gazing down at a landscape that looks very different from the way it did decades ago -- thanks to a long-term emphasis on optimized use of renewable power.



Scenario 2040: Worlds Apart

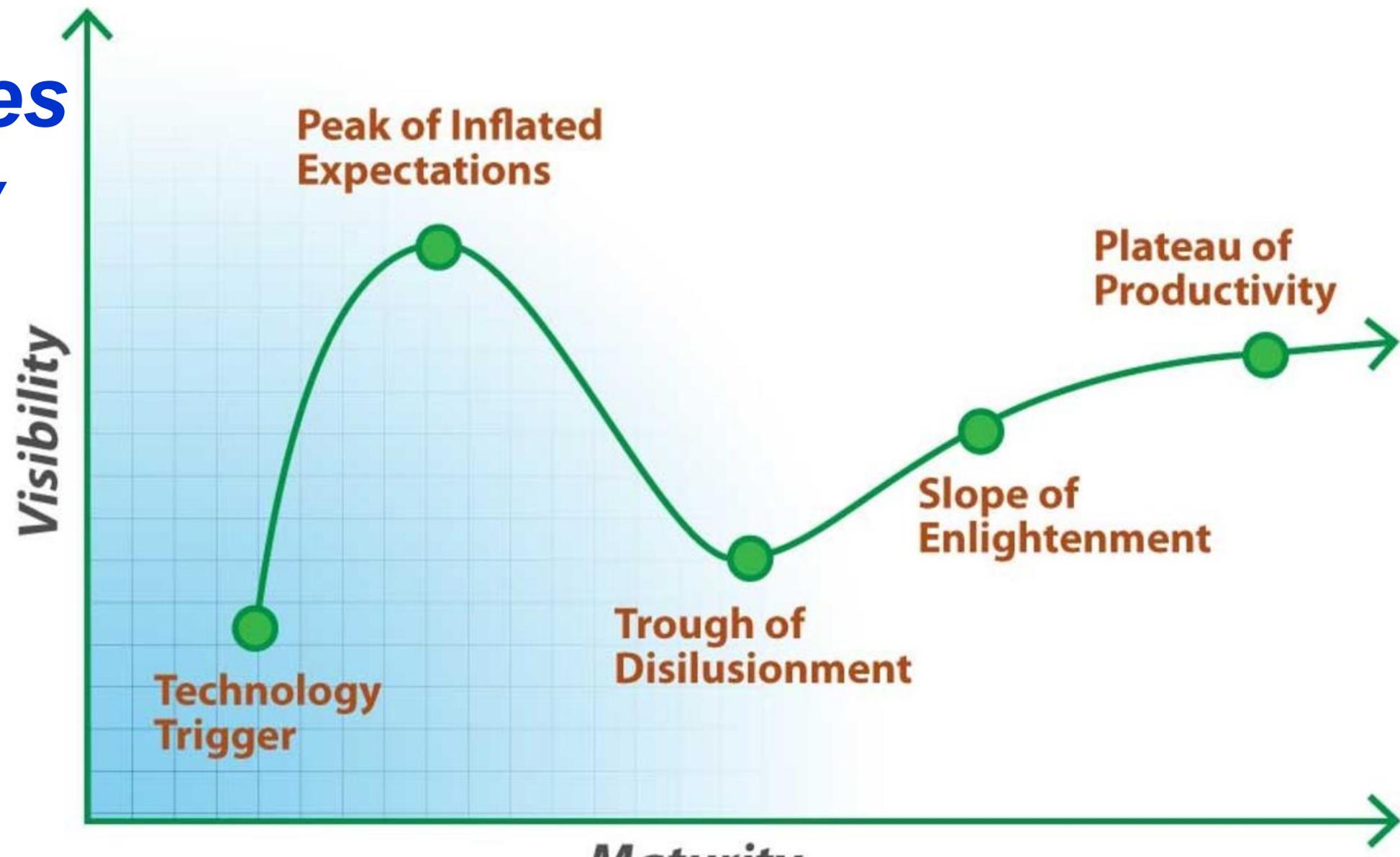
A Chinese megacity in 2040. Li is visiting his grandfather Jun, who lives in an oasis of peace on the edge of this ultramodern metropolis of 25 million people. Two worlds exist in parallel in the same city - acceleration meets tranquility, and living for tomorrow contrasts with living in the Present.



Long-term Strategic Planning:

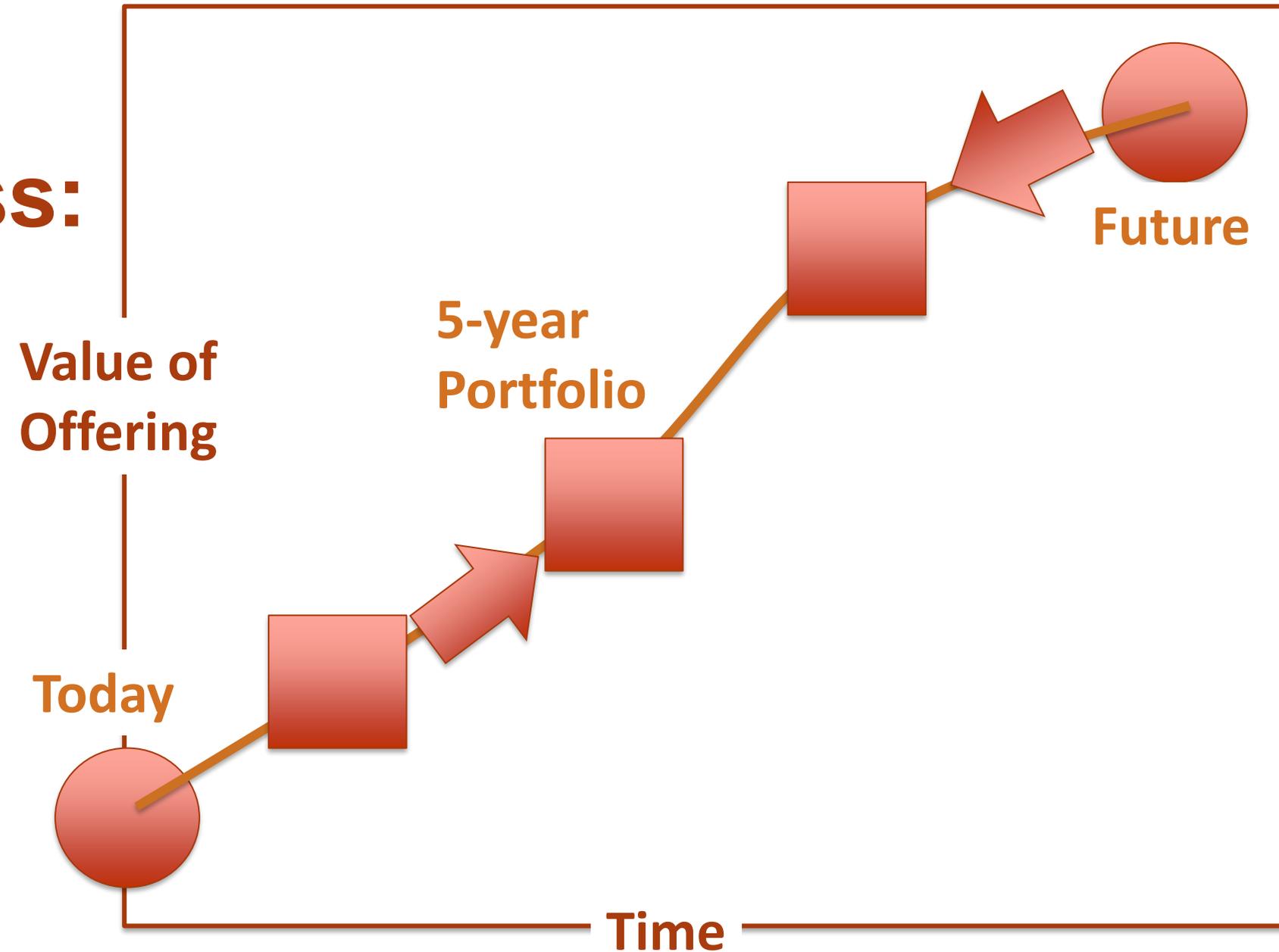
Typically, Industries follow Technology Forecasting Tool

Gartner's Five-Step Hype Cycle



Long-term Strategic Planning:

- ▶ **We shall discuss:**
 - **Retropolation process:**





Mapping of trends- Use case- Future Television

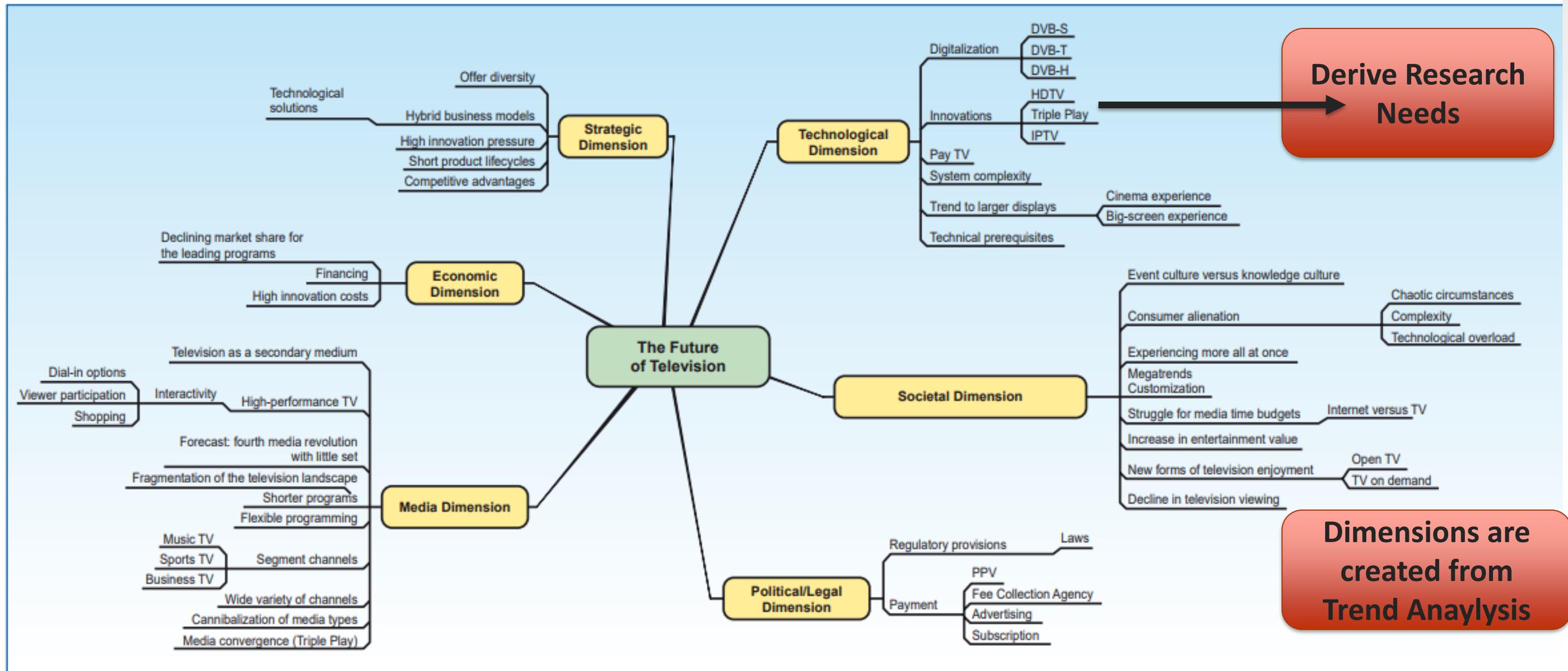


Figure 59 The mind map: medium for initial structuring

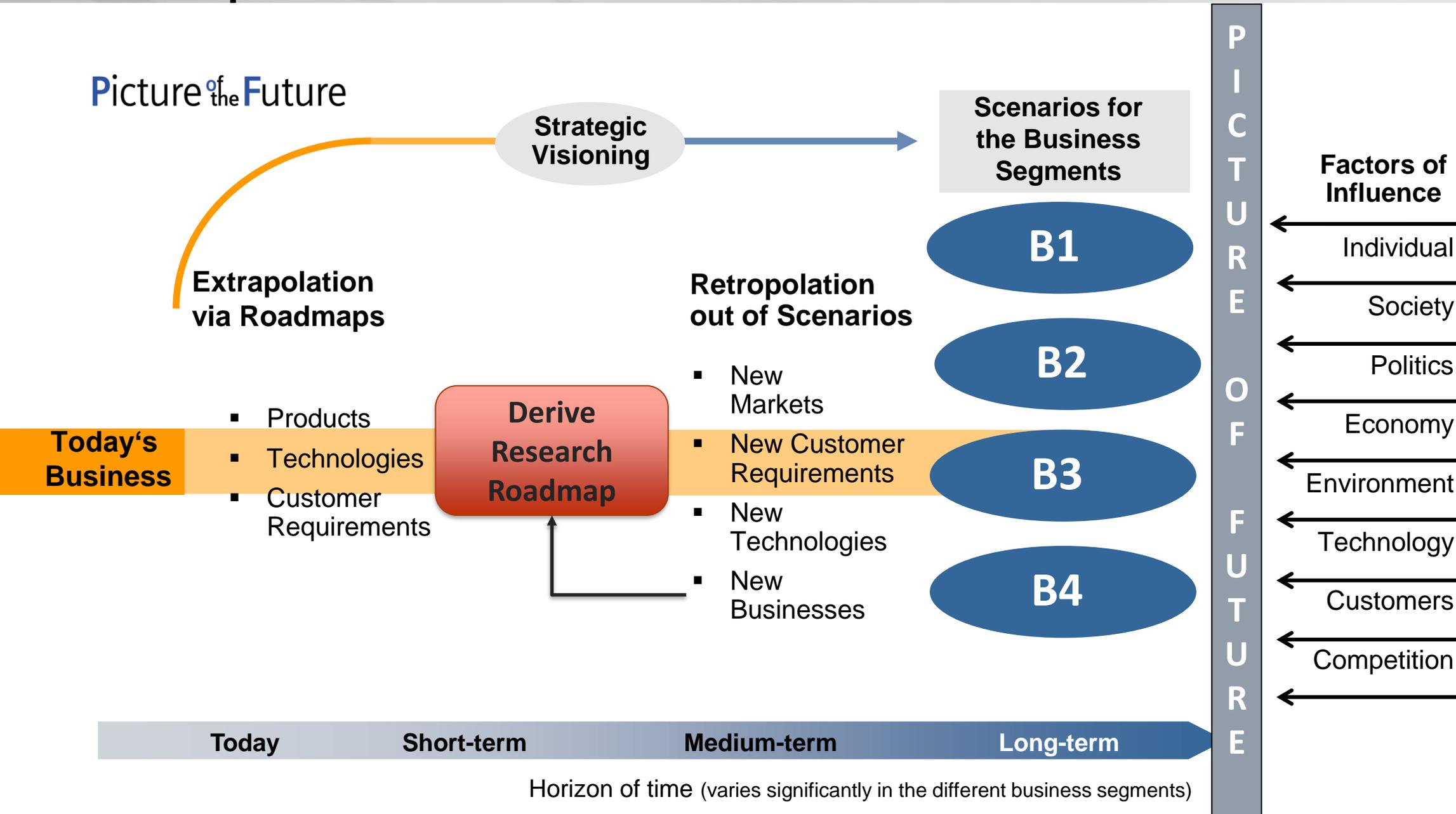
Business Innovation:



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Strategic planning: the combination of extrapolation and retropolation leads to the Pictures of the Future





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Thank you

<https://www.accenture.com/us-en/insights/industry-x/manufacturing-systems-architecture>

<https://www.enelgreenpower.com/learning-hub/energy-transition/energy-digitalization>

<https://unece.org/sustainable-energy/energy-efficiency/digitalization-energy>

<https://www.mckinsey.com/industries/oil-and-gas/our-insights/digital-transformation-in-energy-achieving-escape-velocity>

Bibliography

<https://www.unep.org/explore-topics/energy/what-we-do/digitalisation-energy>

<https://emtemp.gcom.cloud/ngw/globalassets/en/information-technology/documents/insights/the-gartner-it-roadmap-for-digital-buisness-transformation-excerpt.pdf>

<https://www.mckinsey.com/industries/financial-services/our-insights/a-roadmap-for-a-digital-transformation>