SYNAPSE

Why Pursue

?

By
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In this second chapter, we will show that IoT is about the "Information of Things". The value of IoT follows the Pyramid of Knowledge, generating increasing value as data gathered from IoT devices is processed into information and the resulting knowledge & insights.

Key Takeaway

IoT is about the "Information of Things": the value-added of IoT comes from the use of the information gathered from the IoT system and the resulting knowledge & insight

THE FINANCIAL BENEFITS

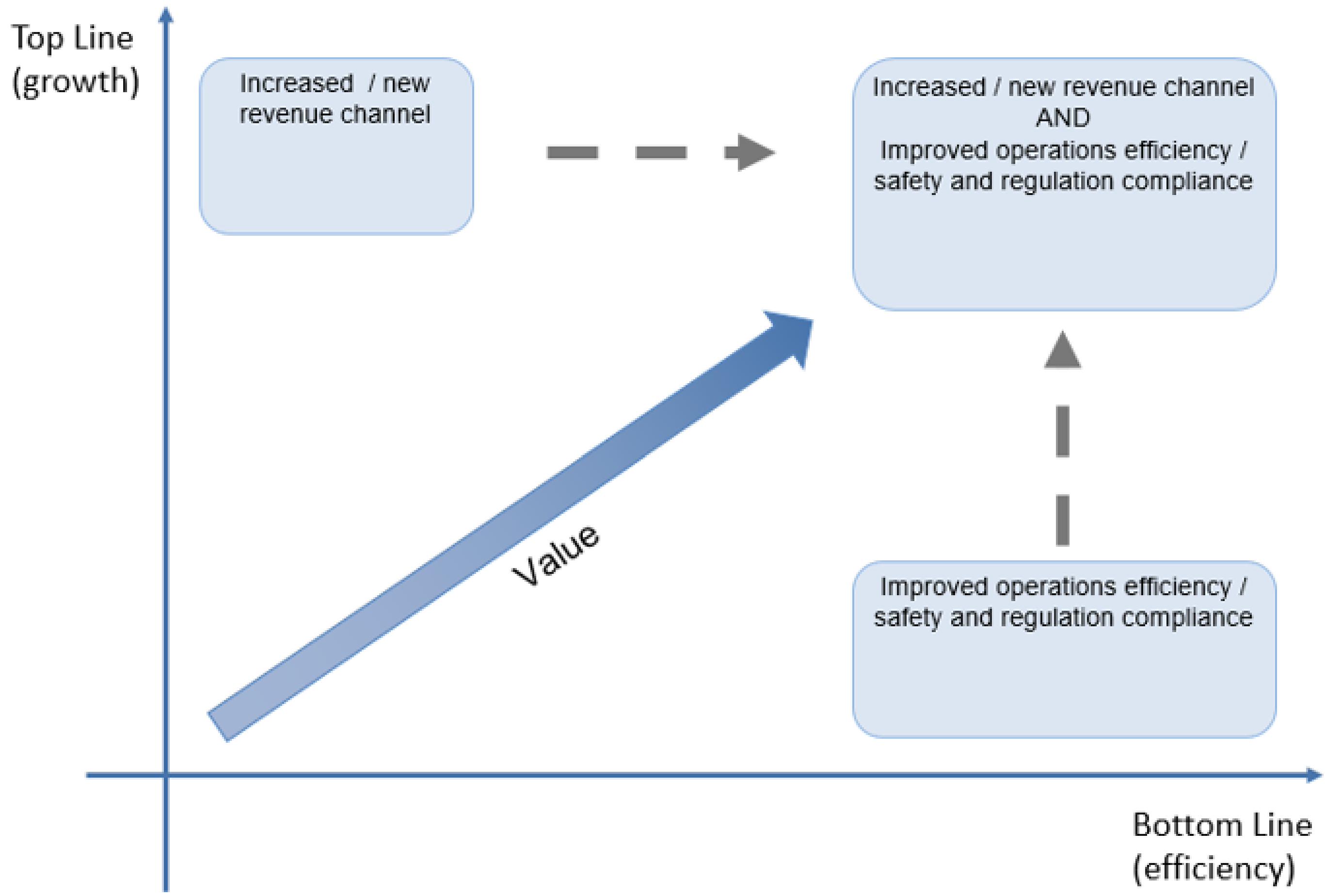
An Internet of Things journey is a digital transformation journey using technology to radically improve performance or reach of an enterprise, leveraging digitized information insights to generate new value.

This value of IoT can benefit the top-line and the bottom-line, through:

- **Increased or new revenue channel**
  Examples include converting an offering into a recurring subscription service, generating new revenue by packaging and selling sensor data, charging a premium for connected product, or monetizing an ecosystem platform.
- **Improved operations efficiency**
  Examples include smart manufacturing and industry 4.0, asset tracking, or predictive maintenance.
- **Improved safety and regulation compliance**
  Examples include workplace safety monitoring, connect panic buttons, automated quality assurance, or chemical leak detection.

Raconteur shows in the Secrets of IoT Success that those who reported the largest reduction in costs also reported the largest increase in revenue.

A well-planned and executed IoT journey can leverage generic IoT capabilities and support information correlation across different domains, therefore delivering both increased revenue and higher margins.



IoT benefits used to be speculative forecasts, but there are now many published quantified financial benefits realized from implemented IoT journeys:

TOP-LINE CASE STUDIES

- The global smart home devices market reached $66B in 2018 and is forecasted to grow at 20% CAGR until 2027 with the global smart speaker market size valued at $4B in 2017 and a forecasted 23% CAGR through 2025.
- IoT Analytics links the $22B in 2019 equipment-as-a-service market recent growth and forecasted 35% CAGR to IoT technologies.
- Embraer 175 jet aircraft market share increased from ~40% to ~80% through digital engineering.
- Cap Gemini reports that 73% of those who have used smart city initiatives say they are happier with their quality of life in terms of health factors, such as air quality

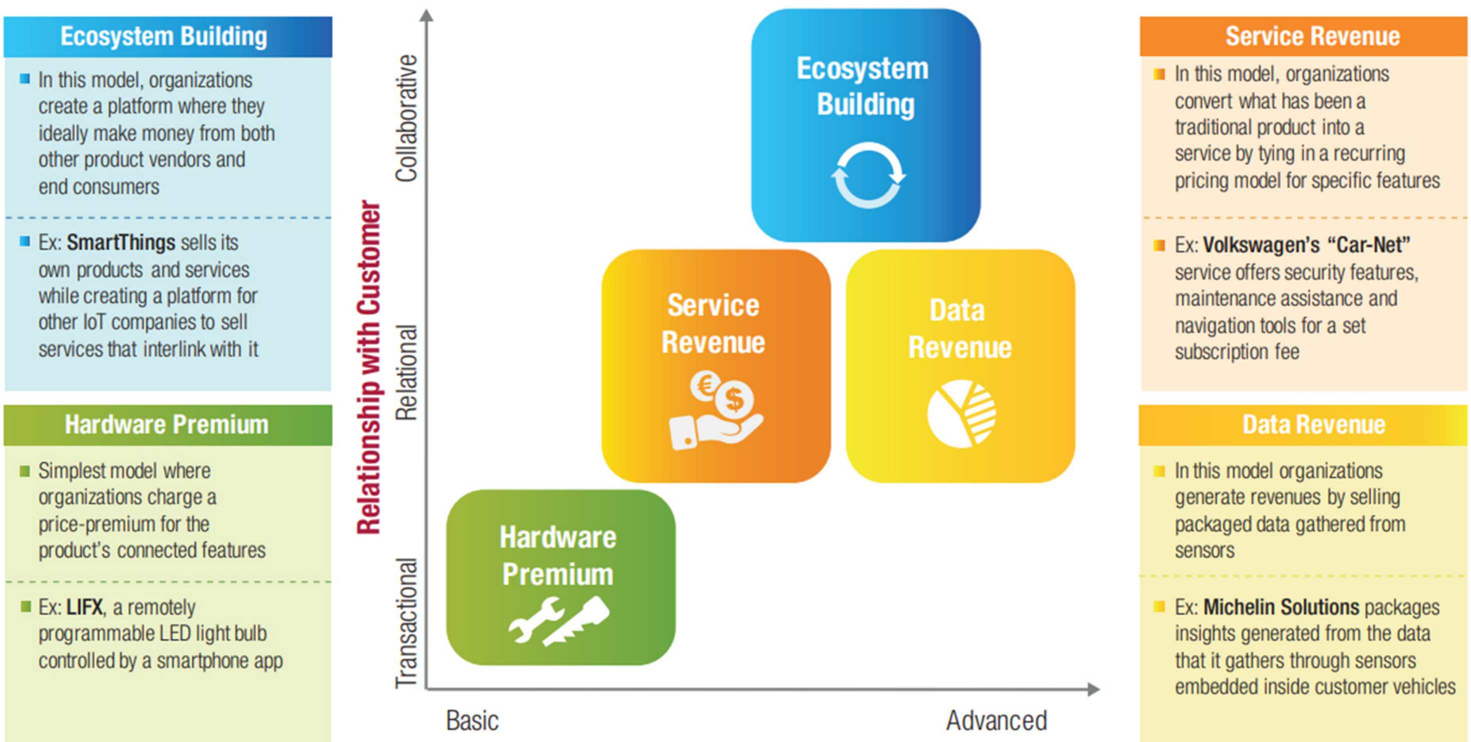
BOTTOM-LINE CASE STUDIES

- AirAsia reports annual savings of 1.27 MM kg of fuel, 4,013 mtCO2 and 34,657 minutes of delays.
- Southern, a railway operating company in the UK reports a 63% reduction in delays.
- Baker Hughes, a GE company, reports a 12% increase in machine utilization five months after the deployment of the solution and the prevention of 26,000 hours of downtime (in one year across all BHGE's plants in Italy).

- Accenture reports 25% to 32% returns on digital investments for adoption champions.
- McKinsey reports numerous quantified benefits, including 30% efficiency gain in product planning, 90% in defect detection, amortization in less than 20 months of a robotic inspection, 10% production yield increase through interactive work instructions and process analytics, and many more.
- GE reports savings in excess of $1.5B for their clients through the use of digital twins.

However, tangible financial top-line and bottom-line benefits may not be the only reason to pursue an IoT journey; there is also value to be gained from more intangible benefits such as improved customer relationship through better engagement and collaboration.

Capgemini, Synapse's parent company, has mapped the Monetization Models for the IoT to the customer relationship and the complexity of models:



Complexity of IoT Monetization Model

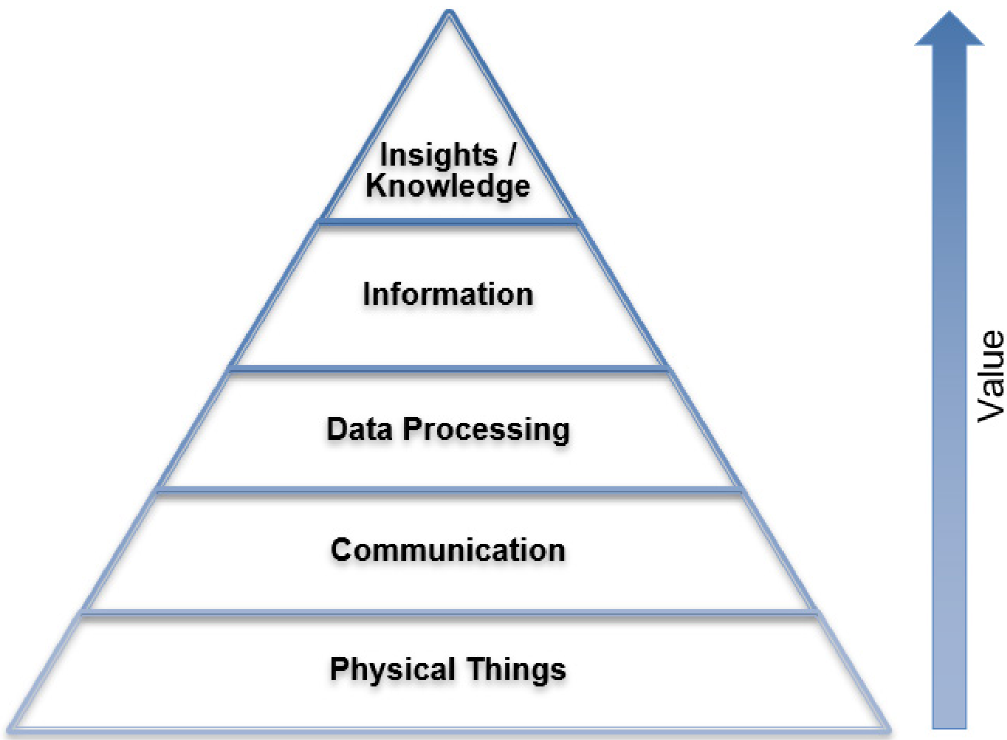
As for the compounded benefits of pursuing both top-line and bottom-line approaches, benefits can be further increased when pursuing multiple monetization models in an IoT journey.

Note that there is a significant benefit variance between champions (aka leaders) and cadets (aka laggards), so careful planning and execution of the IoT journey are critical success factors. In the last post of this sequence, **When** to start an IoT journey, we will provide the characteristics of a successful IoT and digital transformation journey.

All the IoT monetization models listed above have one thing in common: they rely on the information collected by the "things" to generate value and enhance the relationship with customers.

IOT IS ABOUT THE "INFORMATION OF THINGS"

The value-added of IoT comes from the information gathered from the IoT system and the resulting knowledge & insights.
Let's look at the Pyramid of Knowledge as applied to the IoT domain: an end-user, whether consumer or business, will gain value only once the data collected by a sensor is transmitted to a processing layer that can then deliver useful information.



Let's walk through the example of a temperature sensor and how the resulting information is obtained:

- Physical Things:
  An outdoor thermocouple sensor produces a temperature-dependent voltage, let's say 1.22 millivolt.
  This thermocouple is wired to a IO pin-out on the gateway.
  This analog voltage is converted by the gateway to a digital value for a variable of the appropriate type: Float thermocoupleVoltage = 1.22; //(unit is mV)
  Which doesn't tell us if it's hot or cold.

- Communication:
  The digital value is transmitted to a cloud back-end by the gateway using a Wi-Fi network to access the internet.

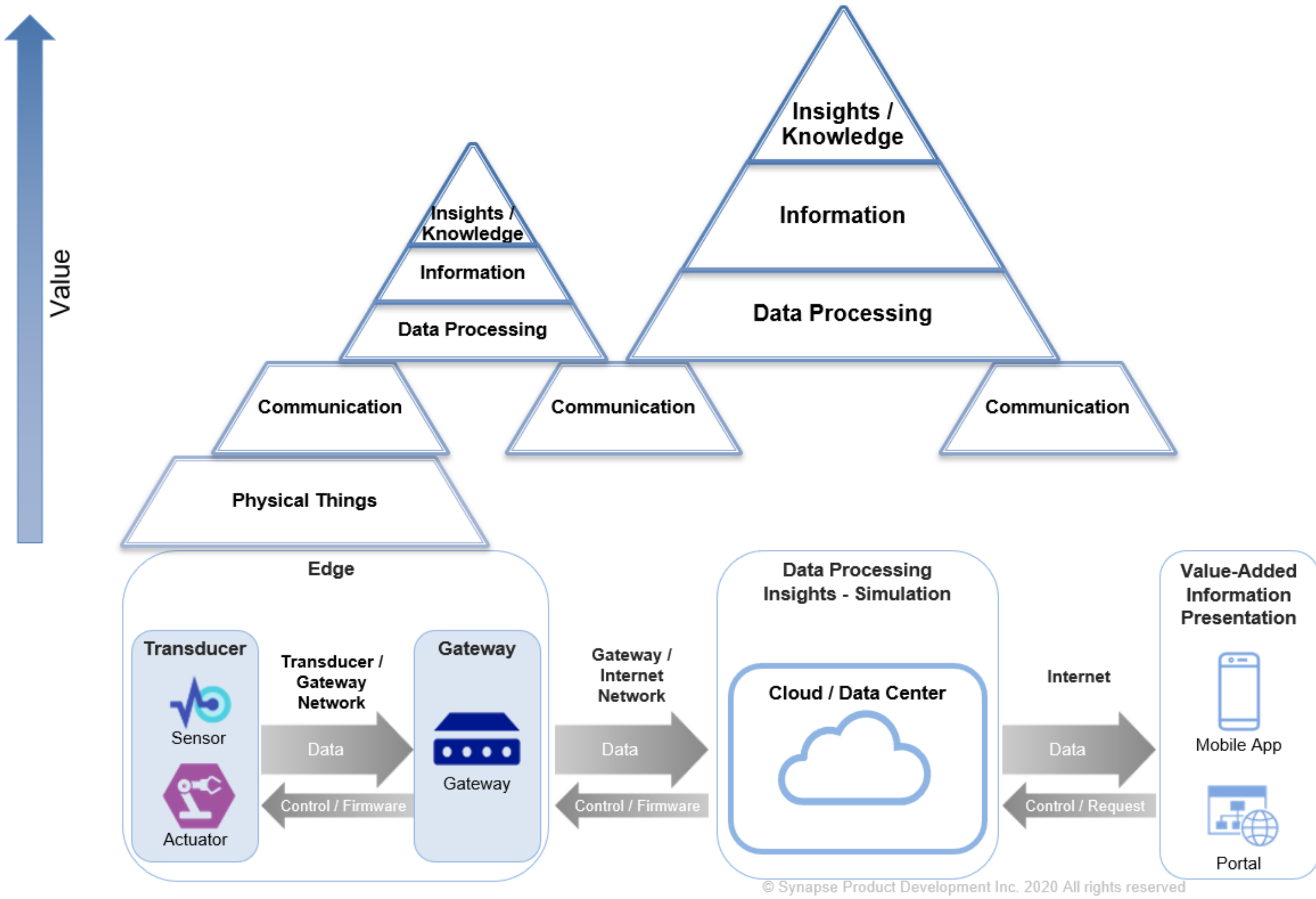
- Data Processing:
  The digital value is received in the cloud back-end and processed to convert the voltage value into a Fahrenheit value by applying the relevant conversion and extrapolation formulas.

- Information:
  The computed value is a temperature in Fahrenheit degrees: Float outdoorTemperature = 77; // (unit is Fahrenheit)
  Now this is information as 77°F is a warm temperature and I don't need a jacket to go outdoors.

- Insights / Knowledge:
  Historical hourly temperature over the last 10 years can provide insights into long-term trends and variances. When applying a machine learning model, a temperature forecast can be inferred so that we predict the probable temperature for the next day.

Even though there may be data processing into information, insights, and knowledge at the edge (such as machine learning at the edge), most of the data processing is done in the cloud / Data Center tier.

Below is the mapping of the pyramid of knowledge layers to the IoT architecture layers:

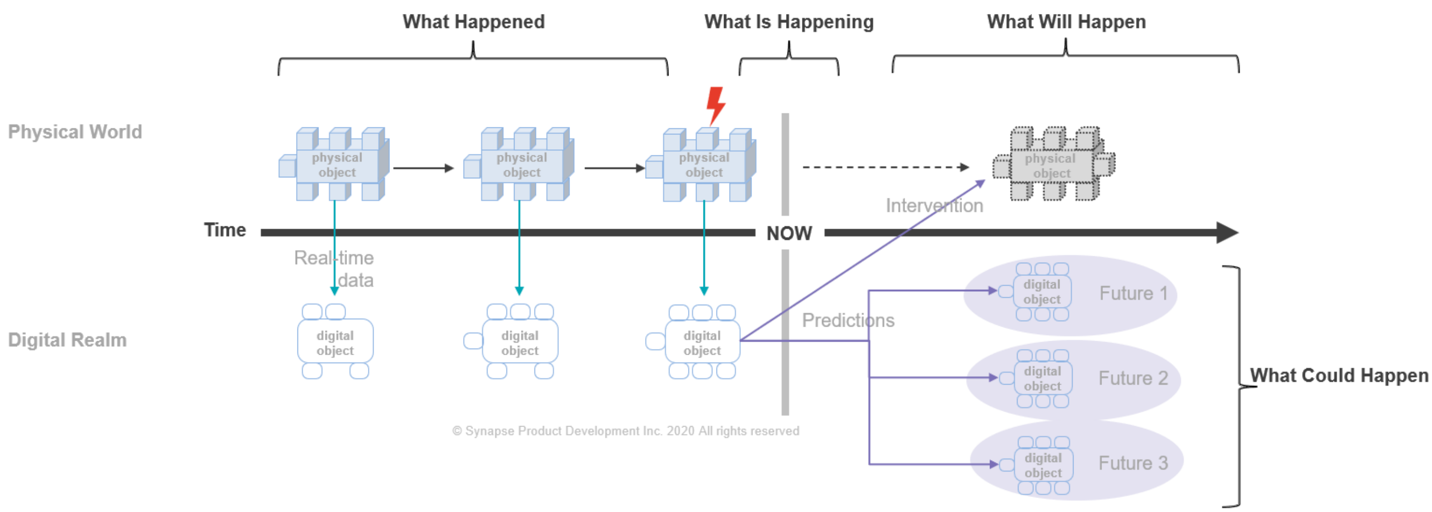


As mentioned in post #1, some data processing and machine learning features may also take place on a gateway with enough processing power, but only processing data streams related to the few sensors connecting to that gateway.

DIGITAL TWIN INFORMATION AND THE TIME DIMENSION

As we have seen in the first post, the digital twin model provides a digital representation of a physical object over time, with the captured information providing historical data, current condition, and future predictions including potential alternate futures based on hypothetical situations.

The information can be categorized along the time dimension: past (what happened), present (what is happening), future (what will happen), and potential alternate futures (what could happen).



These digital twin information categories have different characteristics and will bring different value profiles depending on the relevancy of the use case for a given IoT journey.

Below is an overview of these characteristics such as data velocity: how long should it take for the data to progress from the bottom of the pyramid of knowledge to its top.

Information Categories	What Happened	What is Happening	What Will Happen	What Could Happen
Description	Historical manufacturing, operations, and contextual data	Operational data	Insights & Predictive information	Hypothetical What-if simulation modeling
Primary Data Domains	Device Domain Reference Domain Telemetry Domain	Device Domain Telemetry Domain	Insights & Predictive Domain Reference Domain Telemetry Domain	Simulation Domain Reference Domain Telemetry Domain
Data Examples	Composite material turbine blade resin curing temperature and duration	Turbine rotational speed Turbine blade thrust load	Turbine blade lifespan variance Turbine blade remaining useful lifetime Anomaly detection	Impact of lighter materials in the turbine blade manufacturing process to the turbine blade useful lifetime
Data Velocity	Days	Seconds (or fractions of seconds)	Hours	Hours
Typical Data Sources	Manufacturing process controls historian repository, Environmental weather historian repository	Real-time operations monitoring systems	Data warehouse combining data from the Telemetry and Reference Domains repositories	Data warehouse combining data from the Telemetry and Reference Domains repositories
Transmission Method Examples	Flat file batch	Asynchronous MQTT API Synchronous REST API	Asynchronous MQTT API Synchronous REST API Flat file batch	Asynchronous MQTT API Synchronous REST API Flat file batch

Note:
In the post #4 **How** to build an IoT solution: we will explore the key architecture and design considerations required to realize the expected value, including the conceptual data domains.

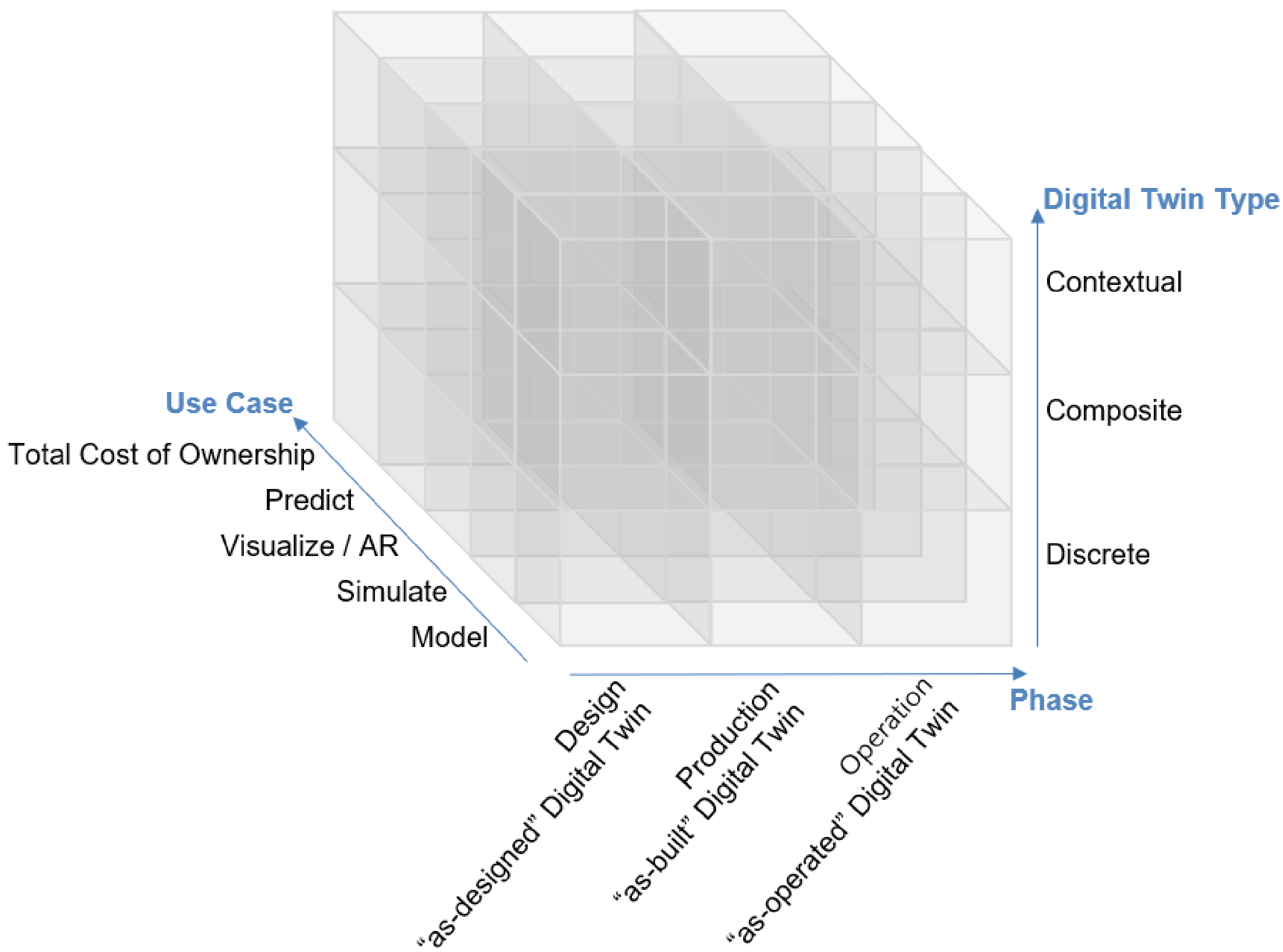
OTHER DIGITAL TWIN INFORMATION DIMENSIONS

Conceptually, a physical object typically lives across 3 phases: a design phase where the object is conceived, a production phase where the object is created, and an operations phase where the object is used.

The digital twin information can be represented accordingly along those three phases.

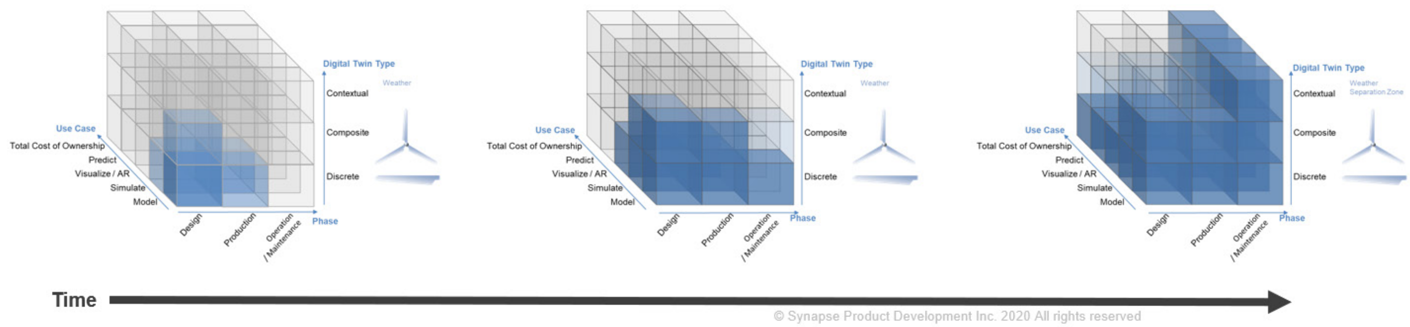
In addition, as we have seen in post #1, there are 3 main types of digital twin: discrete -which is the most granular representation needed for a given domain, composite -which is the assembly of multiple discrete representations, and contextual -which is external context information depending on what is relevant to the domain (such as geo-fencing, weather, separation zone, etc.).

Finally, another common information dimension is based on the prevalent use cases for the given IoT journey, starting with the information modeling and including any combination of simulation, visualization, prediction, total cost of ownership, hypothetical modeling, etc.



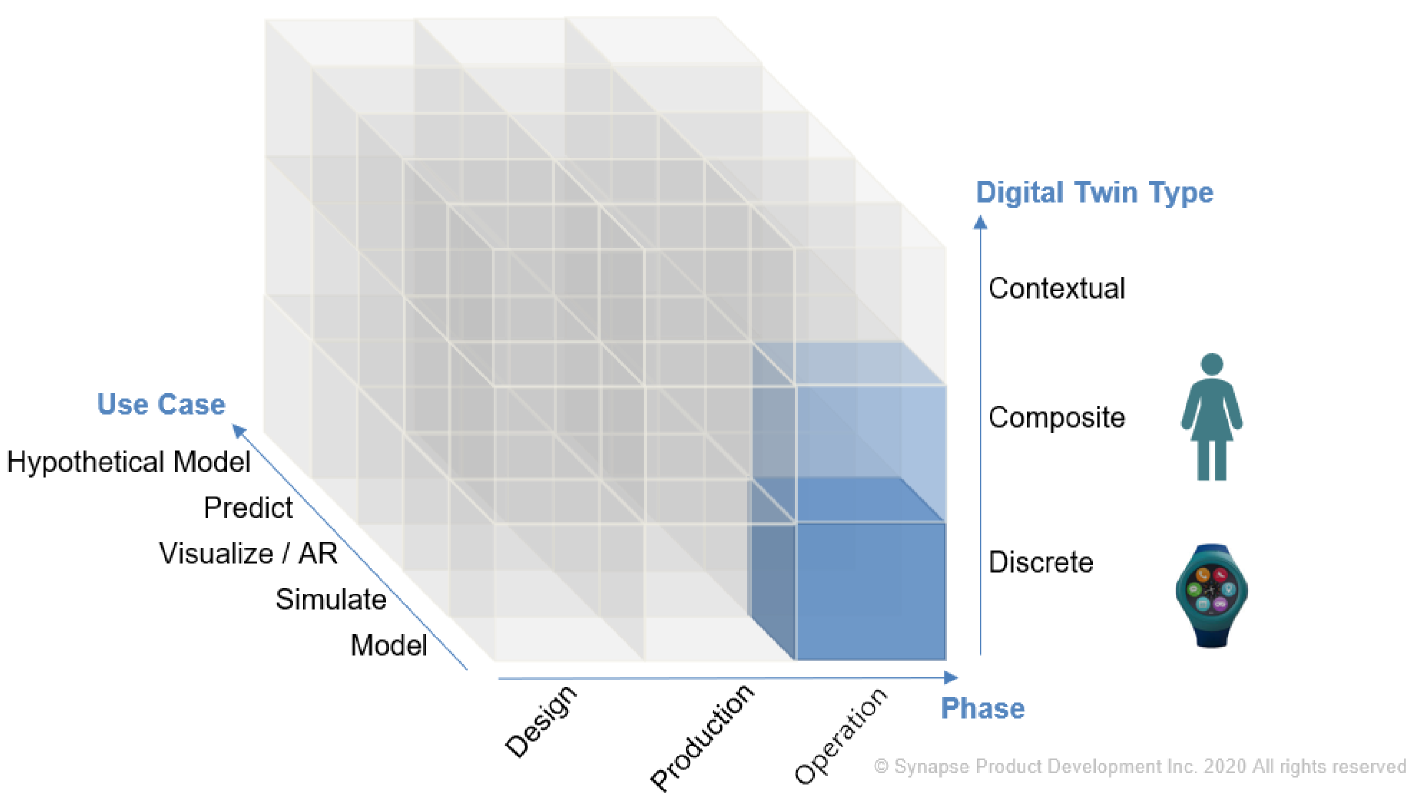
However, only a subset of these dimensions will bring the optimal value in a given IoT journey; there is a point of diminishing return where the volume and processing of collected information may outweigh the benefits. Consequently, the information collected and modeled should be carefully planned and driven by a clearly identified business objective, and following a progressive roadmap.

For example, a wind turbine digital twin model may start with a discrete digital twin of a turbine blade in the design phase, and gradually increasing the richness of the model in the production and then the operation phase.



Notice that even in the end-state, only a subset of the information dimensions is leveraged.

In the consumer wearable market segment, the scope of the digital twin information may only be valuable in the operation phase, with a discrete granularity relevant to the domain.
For example a smartwatch may be modeled as a discrete digital twin from the user's perspective (operation phase); furthermore, the user's heart rate and temperature information may also be captured, which could be modeled as a composite digital twin.
There may not be enough value from other use cases such as simulation or prediction so those would remain out-of-scope; though some of these use cases could be added later, for example should customers ask for heart rate prediction ahead of a new jogging itinerary.



It is this ability to travel through these numerous dimensions, along with time, that unlocks the value of IoT.

However, it is easy to collect data aimlessly, hoping to one day need it, but ending up with an overwhelming amount of unstructured data consuming an excessive amount of processing power along with high storage costs.

CAUTION: don't boil the ocean

Efficiency and clarity of purpose are key: clearly identified business objectives should drive the information collection and digital twin model(s).

Only the information required for a given domain should be collected and modeled in a digital twin; this should be driven by clearly identified business objectives.
As discussed above, champions can expect 25% to 32% return on digital investment provided that their digital transformation journey remains efficient and with clearly identified business-driven objectives.

In the next post **Who** is involved, we will describe the roles involved in an IoT journey and how the IoT vast technical complexity translates to organizational challenges.

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