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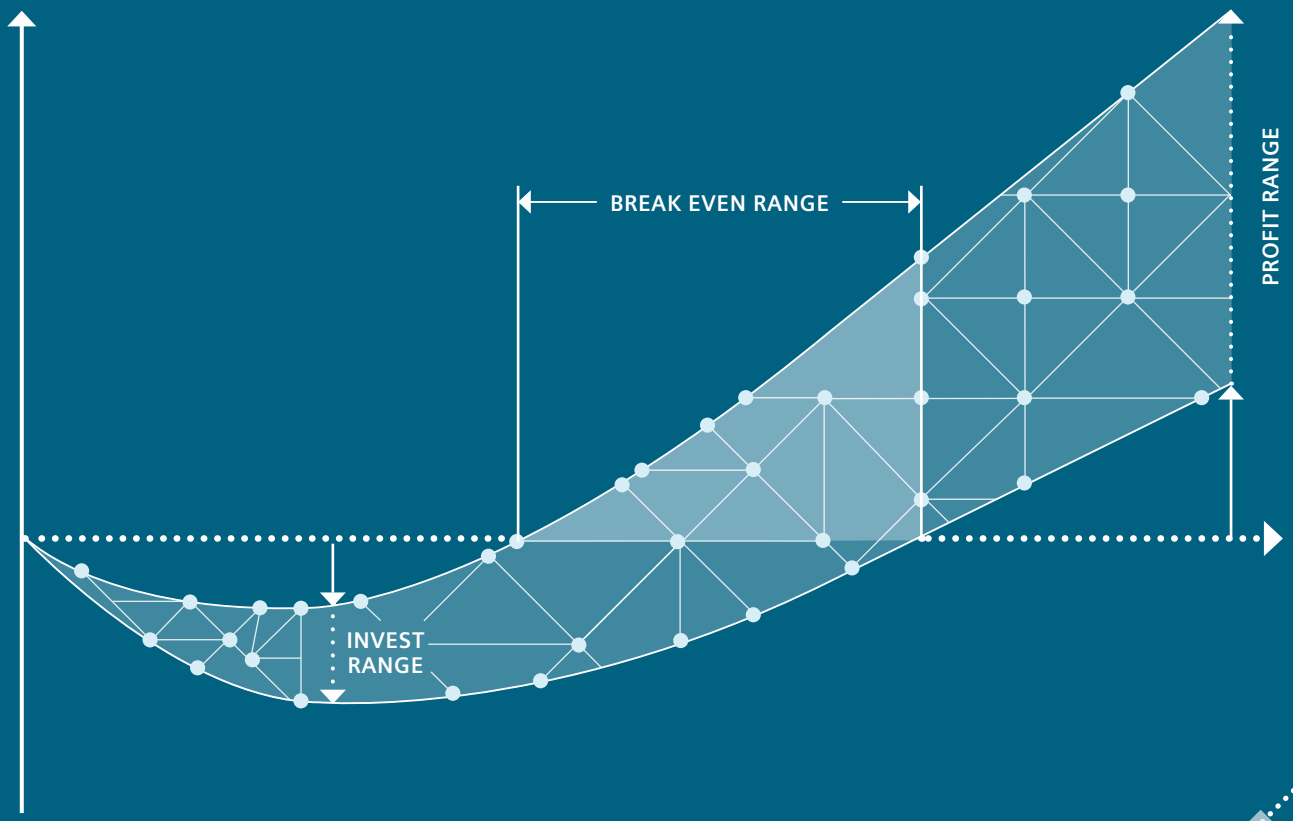
INTERNET OF THINGS – FROM BUZZWORD TO BUSINESS CASE

How to accurately calculate the ROI of IoT initiatives



The Internet of Things (IoT) is radically changing the way we live and work.

IoT as an enabler for digital transformation can create value for private and public organizations alike when optimizing processes or generating new business models out of data.

However, CEOs and CFOs alike struggle with assessing the financial impacts of IoT investments, preventing them from igniting the transformation.

Everybody is talking about the Internet of Things – a buzzword supposed to magically solve all challenges inherent in digital transformation. With such projections, company leaders feel the urge to invest in IoT but are often held back by a lack of accurate and credible calculations for the expected return on potential initiatives.

According to our HBR pulse survey, 80% to 90% of respondents can't accurately measure ROIs for their initiatives.[1] Not to lose traction against their competitors, some companies even start initiatives or projects without a proper business case at hand. Unsurprisingly, failure rates of digital transformation initiatives lie in the range of 60% to 85%. The good news is that most of the elite group that do measure returns are seeing relatively quick paybacks.

This paper focuses on the principles of how to accurately calculate the ROI for IoT initiatives.

Modelling impact chains provide transparency from A to Z.

Impact chains give insight into the complete cause-and-effect relationships from the actions on an operational level to the impact on the business level. It is, therefore, always an interdisciplinary exercise.

Including uncertainty in the ROI calculation increases the credibility of the results.

Realistic ROI calculations never yield a single result, but always produce a range of possible outcomes. If the calculation explicitly handles uncertainty ranges in the impact model, the credibility of the results will significantly increase.

ONLY INVEST IN IOT IF YOU HAVE A CLEAR BUSINESS GOAL

The IoT is changing the business landscape across industries. IoT can deliver benefits in many areas, from optimized business processes with increased output, lower costs, and higher quality, to new business opportunities based on data-driven business models.

Finding the right access and starting the digital transformation journey, however, seems to be difficult as C-level executives report in our HBR study. Beginning your own digital journey requires defining a meaningful use case and creating a solid value proposition. What is it that you want to achieve?

Each digital journey is unique. The right access to IoT technology as the enabler of this journey depends on the actual business situation of a company and what it envisions for the future.

One of the biggest obstacles to getting started – next to identifying the right use case – seems to be accurately quantifying the return on an IoT investment. This is somewhat surprising, as the need to demonstrate business value is not unique to IoT.

WHY IS THAT?

Conversations about IoT often focus on the "things" themselves – sensors, devices and machines. In the early days, the industry was obsessed with the magnitude of the network and forecasting how many devices might be connected. This, of course, is of little or no relevance to most industrial companies. It simply does not deliver any incremental value. As the fascination with an astronomical number of connected devices is subsiding (due to the cost they incur), the conversation is now moving towards how IoT technologies can deliver value to the business through optimized operations and new business opportunities.

So, companies must be careful to avoid falling in love with the coolness factor of the technology. The technology must serve the business, not the other way around.[2]

Today, many companies are still in the exploration phase. Their focus is on trying to better understand the new technology and its possible applications. Since there are so many different opportunities and the business impact of different paths remains opaque, picking the best strategy for the IoT journey remains a challenge. Before making decisions on expensive IoT implementations and choosing the direction of your journey, define your business goal as precisely as possible. Only then will you be able to accurately measure whether it will pay off in the future.

For practical guide on where to start, take a look at our whitepaper: "IoT – Turning the Internet of Things into reality."[3]

One example of adding real value for a business is setting up predictive models that combine data from connected devices with other operations and business data to optimize maintenance scheduling for manufacturing equipment. This increases overall availability and avoids costly unplanned downtimes.

In this case, the business goal is to increase the overall equipment effectiveness and value is derived from greater output from the same setup.

ROI IS DEFINED BY CUMULATIVE CASH FLOW

As businesses are ready to invest in IoT technology, they are looking for proof of its payback.

At recent IoT conferences, the question of how to measure the ROI for IoT projects has regularly drawn tremendous interest among participants. Let's start with a clear definition of the term ROI.

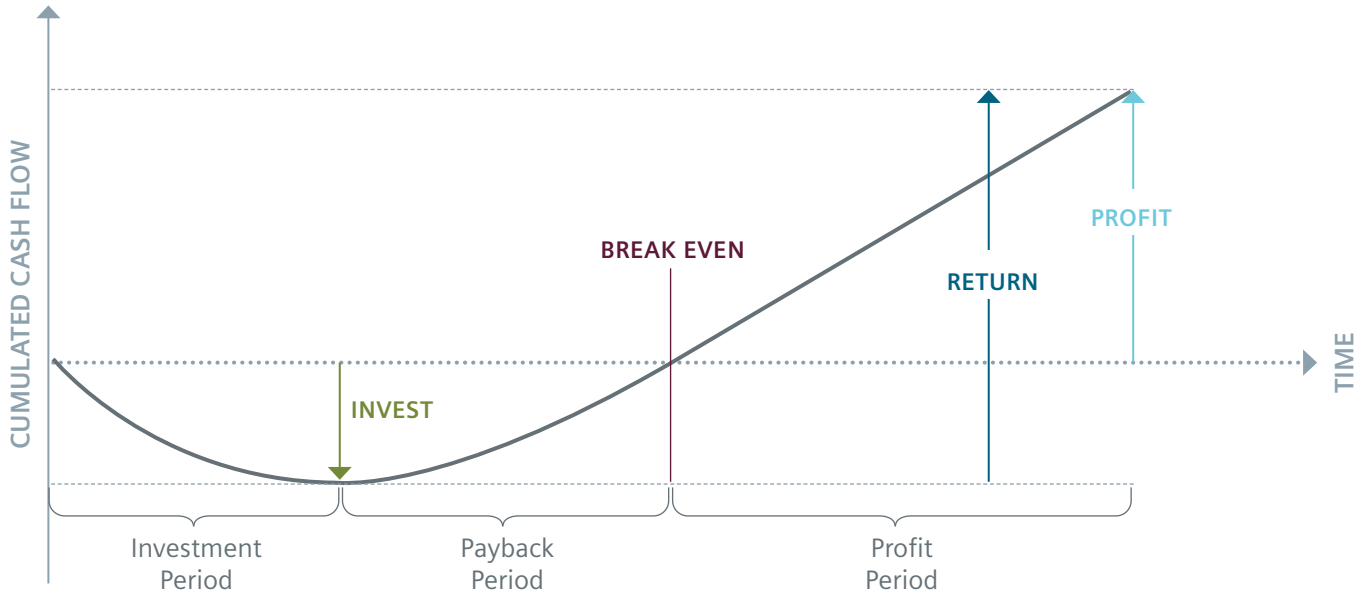
ROI is the ratio between the profit after a period of time and the cost of the investment. The profit is the return, after subtracting the cost of the investment. The profit is therefore the difference between cash inflow and outflow. The break-even point (BEP) has been reached when the cumulated cash flow equals the initial investment. Often the cash flows are discounted to their present values to make them comparable over time. The present value of a series of future cash flows is referred to as the net present value.

The purpose of the ROI metric is to measure the rate of return on money invested in order to decide whether to undertake an investment. It is also used as an indicator to compare different investments. The investment with the highest ROI is often prioritized, even though the spread of ROI over the time period of an investment should also be considered.

Return on invest measures the gain or loss generated by an investment relative to the amount of money invested.

ROI is the ratio between profit and the cost of the investment.

$$ROI = \frac{PROFIT}{INVEST} = \frac{RETURN - INVEST}{INVEST}$$

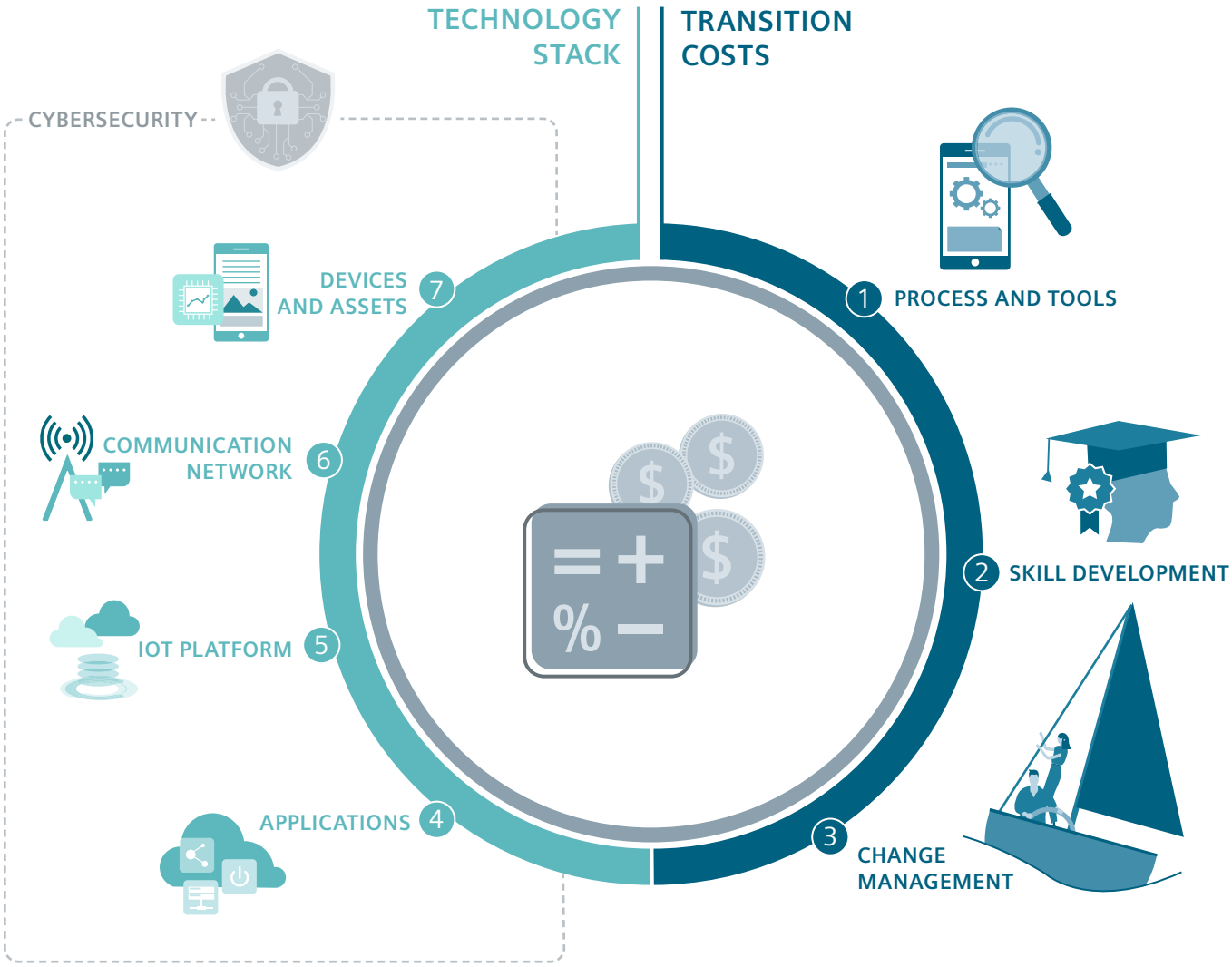


COLLECT THE BITS AND PIECES FROM A TO Z TO DETERMINE THE INVEST FOR AN IOT INITIATIVE

As basis for estimating the cost, every project should be structured into manageable work packages. For an IoT initiative, all technical and non-technical ingredients must be identified accordingly.

An IoT initiative will always consist of the implementation of the IoT solution along the IoT stack. But it cannot be limited to this, as the IoT solution will have tangible effects on business strategy, business processes, and the people and culture of the organization.

Therefore, the budget for an IoT initiative must cover not only the direct investment for the complete technology stack including infrastructure for data processing and storage, license or subscription fees as well as resources for cybersecurity. It also has to cover the transition costs including efforts for processes and tools, skill development, and Change Management to facilitate a successful digital transformation.



TRANSITION COSTS

Digital transformation requires far more than just implementing a new technology. It is the change and adaption of the organization to the new technology that makes it a challenge. Above all, it is about people. Many business leaders underestimate the considerable efforts required to turn a digital transformation into a success story. Convincing people to change from what seems perfectly fine today to something that is yet unknown is often more difficult than implementing the new technology itself. The transition costs of an IoT initiative cover everything not included in the direct investment for the technology stack.

1 PROCESSES AND TOOLS

New technologies require new ways of working, which means processes must be adapted and new tools might be introduced. Efforts for optimization of processes as well as installation and customization of tools must be considered in the investment budget for the IoT initiative.

2 SKILL DEVELOPMENT

The jobs of today will change in the future. The digital transformation might even require completely new skill sets. Efforts for training existing staff members, recruiting new people with different competencies, as well as the integration effort must be covered in the investment budget.

3 CHANGE MANAGEMENT

The high failure rate of IoT initiatives largely stems from the unique challenges associated with digital transformations, including shifting to a more entrepreneurial culture, working in cross-functional teams, meeting accelerated timelines, and accepting evolving target states. Change Management should be integrated in any IoT initiative from the beginning. If you lead people properly in the first place, you will not have to manage problems later on.

For a deeper understanding of how Change Management facilitates the digital transformation, take a look at our whitepaper: "Successful digital transformation – How Change Management helps you to hold the course."[4]

TECHNOLOGY STACK

The main components of the technology stack include devices and assets, communication networks, IoT platforms, and applications. The investment scales with the number of devices and the size of the data to be processed and stored.

4 APPLICATIONS

Advanced data analytics and machine intelligence offer added value to IoT implementations. Applications present the resulting information to users in an easy-to-understand way.

5 IOT PLATFORM

Data processing and storage can be premise-based, cloud-based, or a hybrid of both. For each use case, the operational requirements define which model is best suited.

6 COMMUNICATION NETWORKS

A wide range of options is available for data transmission, from ubiquitous internet and cellular technologies to analog telephony and even radio.

7 DEVICES AND ASSETS

The assets of interest are equipped with sensors and actuators, edge devices that enable processing power, as well as gateways that allow data flow from one network to another.

The technology stack might be the exciting part, but do not forget to provide budget for transition costs if you want to succeed.

MODEL THE BUSINESS IMPACT TO QUANTIFY THE RETURN ON AN IOT INITIATIVE

The return on an IoT initiative comes from harnessing the IoT technology to create business value and is therefore defined by the impact of the solution on business operations.

Measuring this impact requires suitable indicators to capture the relevant aspects of the processes affected by the initiative. The impact of the changes of these indicators on financial KPIs are then considered in the business case.

Any impact, whether it is about solving a specific business challenge or about improving the performance of business operations in general, can be measured by suitable indicators.

In practice, quantifying the expected impact of an initiative is often a challenge since there is usually no direct causal link between the actions of the initiative and the KPIs describing the business situation. That means we must resort to modelling the complete cause-and-effect relationships from the actions on the operational level to the (financial) impact on the business level. Depending on the situation, these interlinked impact chains may stretch across many levels. Modelling is, therefore, always an interdisciplinary exercise and involves both business managers and operations experts. Joint workshops may help managers and domain experts to better understand both sides of the equation.

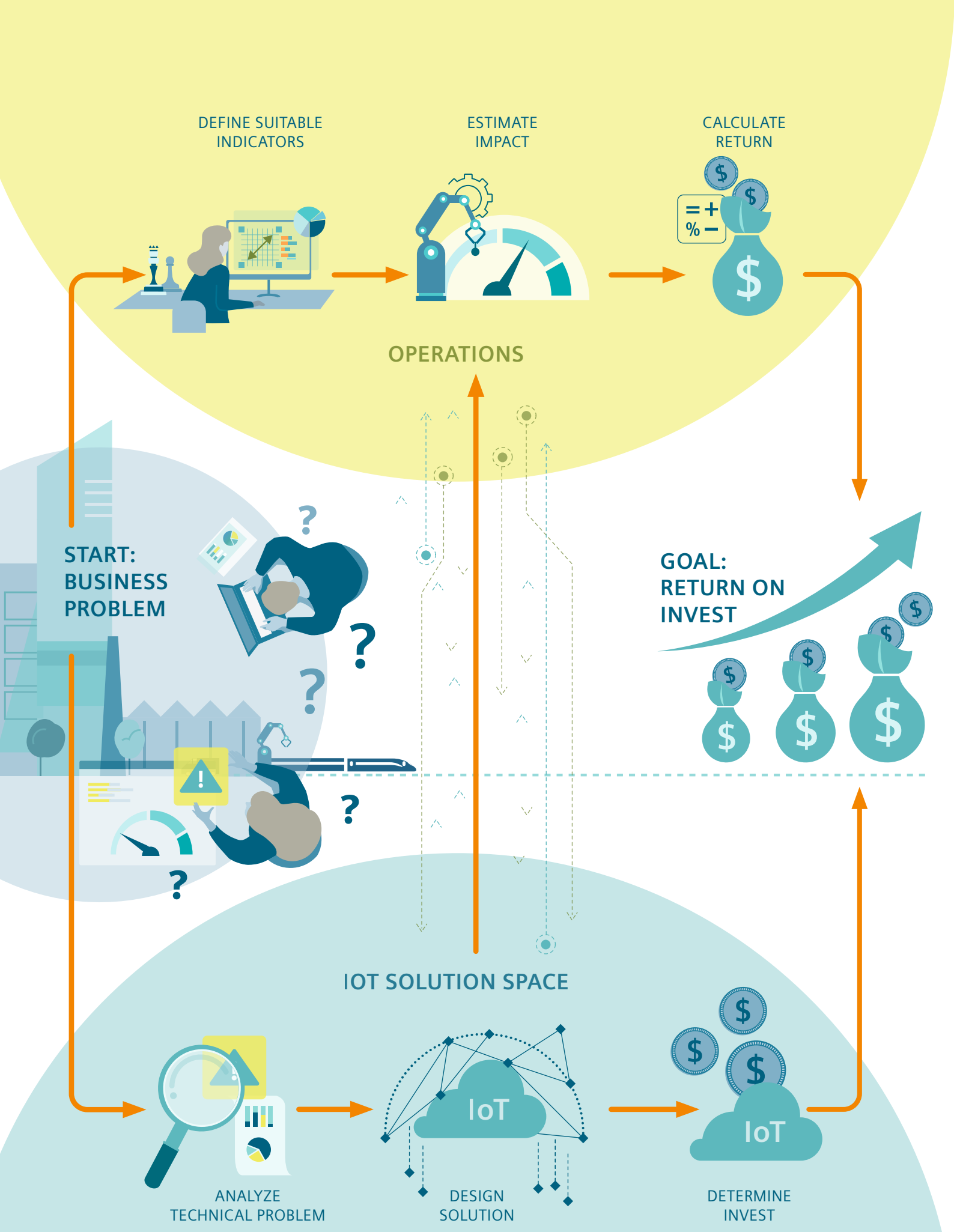
Apart from quantifying the (financial) impact of an initiative, the modelling exercise helps managers to better understand the challenges on an operational level and supports operations experts in getting to know the critical business issues.

In principle, the impact model covers all effects, whether they have a positive impact or not. Experts involved in impact modelling tend to focus on the improved operational metrics which lead to financial savings. But concrete improvements always have costs attached to them. One-time costs as well as recurring annual costs for maintaining the implemented changes must be considered in the cash flows used in the ROI calculation. That means annual benefits or savings are reduced by the annual costs in the profit calculation.

Examples for annual costs include licenses for tools, service fees, maintenance of hardware and software, and additional efforts for new process activities.

MODELLING IMPACT CHAINS

- By modelling detailed cause-and-effect relationships, we obtain a definition of the business value of an initiative as a function of the changes of the indicators on an operational level. By modelling detailed cause-and-effect chains, we gain greater transparency on where and why financial KPIs are improving or declining.
- The indicators are independent variables (the Xs) that are controlled by the actions of the initiative (like downtime due to equipment failures), while the financial KPIs on the business level are dependent variables (the Ys) that are indirectly affected by the changes of the indicators (like gains due to higher manufacturing output). The business case is based on estimated changes of the indicators.
- The same impact model can, of course, be applied to calculate the true business impact by measuring the actual changes of the indicators after implementation. This allows to verify the original business case in retrospect.

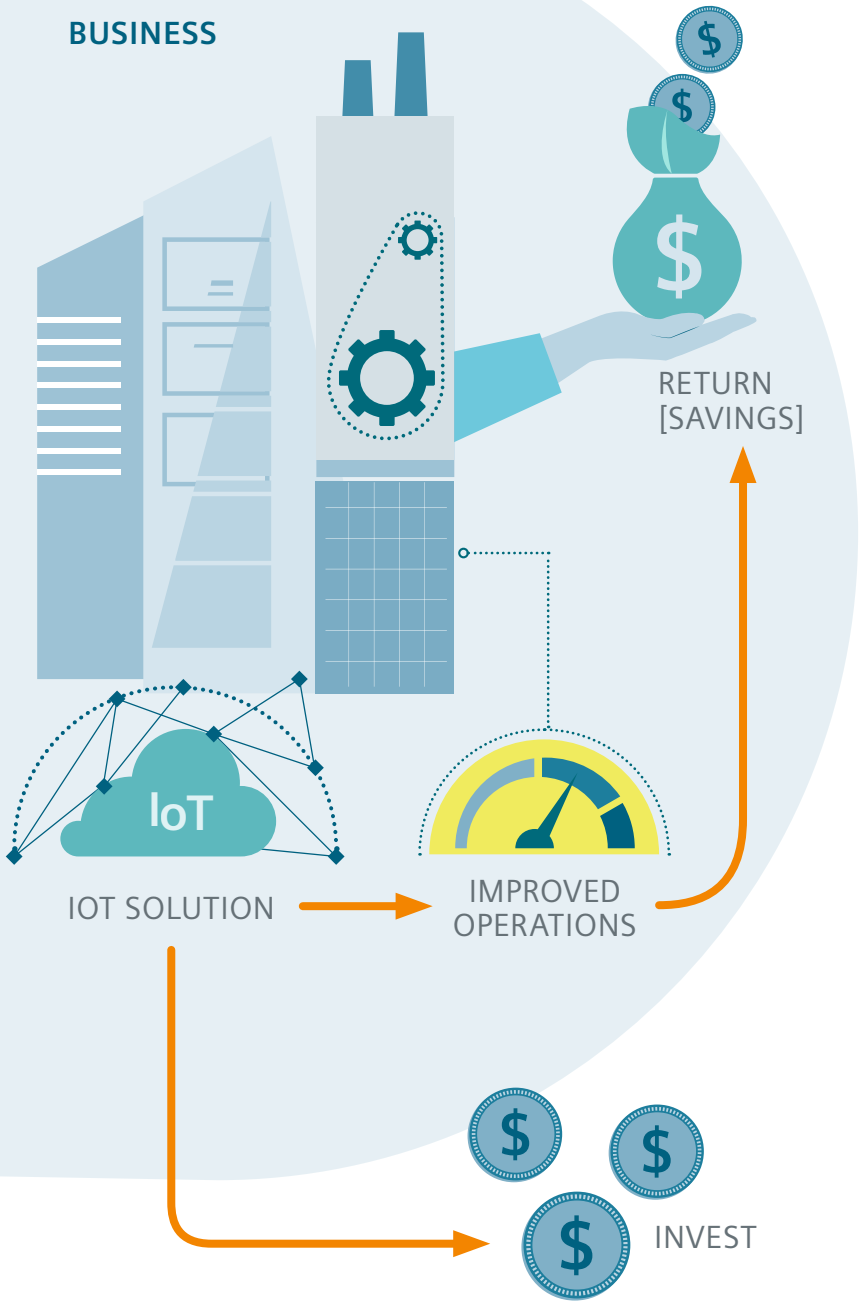

DEFINE SUITABLE INDICATORS
ESTIMATE IMPACT
CALCULATE RETURN
OPERATIONS
START: BUSINESS PROBLEM
GOAL: RETURN ON INVEST
IOT SOLUTION SPACE
IoT
IoT
ANALYZE TECHNICAL PROBLEM
DESIGN SOLUTION
DETERMINE INVEST

Modelling impact chains is the basis for quantifying returns and helps to understand the dependencies between operations and business goals.

TWO SCENARIOS: PROBLEM RESOLUTION VERSUS BUSINESS OPPORTUNITY

There are different ways to generate business value. In this whitepaper, we want to highlight two basic scenarios. In both scenarios, an IoT solution is used to improve business operations.

While in the first scenario the IoT solution is designed by the business itself to solely optimize their business. In the second scenario, the IoT solution is developed to be offered as a service to third parties (customers) to improve their business operations.

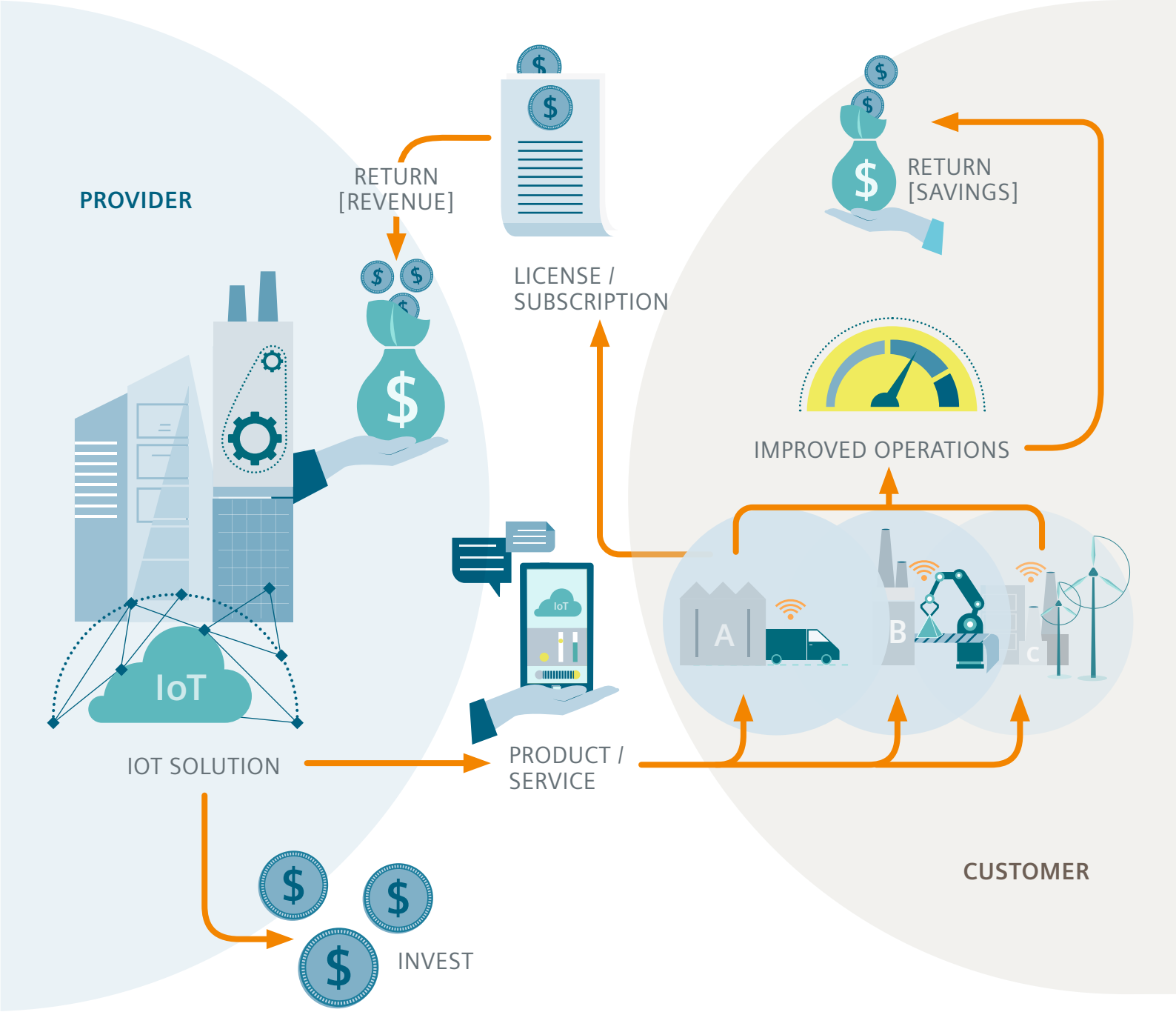


SCENARIO 1: PROBLEM RESOLUTION

A specific IoT solution is designed and implemented by a business to address a specific business issue or optimize its business operations. In this scenario, IoT is a technical solution to a business problem.

The invest is defined by the technology and infrastructure that is needed to implement the solution, as well as the essential transition costs to support necessary changes in the organization.

The profit is defined by the potential savings or benefits from solving the business problem, minus the annual costs for maintaining the solution.



SCENARIO 2: BUSINESS OPPORTUNITY

A provider develops a generic IoT solution and offers this as a product or service to multiple customers to address their business issues or to optimize their business operations. In this scenario, IoT is a business opportunity for the provider, and a commercial solution to a business problem for customers.

- **CUSTOMER VIEW**:
  The calculation of the profit remains the same as in scenario 1, but the invest and annual costs are replaced, at least partly, by licenses or subscription fees for the product or service.

- **PROVIDER VIEW**:
  The calculation of the invest remains the same as in scenario 1, only that transition costs might be lower since the cultural impact is more important on the customer side. But the profit is calculated quite differently: It is defined by the expected revenue stream, which consists of licenses or subscription fees scaled by the number of customers, multiplied by the profit margin.

In any case, in order to determine a reasonable price tag for their offering, the provider must know how much the customers are willing to pay, which means they must understand the customer's business case.

Since these basic scenarios cover the different ways to generate business value with an IoT initiative, calculating the ROI of an IoT solution always requires understanding the impact of the solution on the business operations to be improved.

USE CASE: PREDICTIVE MAINTENANCE OF MANUFACTURING EQUIPMENT

Predictive maintenance is one of the hottest topics in manufacturing.[5]

Many manufacturers have started collecting data from IoT sensors in their factories and using intelligent algorithms to detect warning signs of potential failures before they occur. The purpose of predictive maintenance is to help determine the condition of equipment in order to estimate when maintenance should be performed. This technique promises cost savings over routine or time-based preventive maintenance. The goal is to perform maintenance work when it is most cost-effective and before the equipment performance declines. It also helps to prevent unexpected equipment failures. Traditional routine or time-based maintenance is labor intensive and ineffective at identifying problems that develop between scheduled inspections.

INVESTMENT

In addition to sensors and devices to collect data on equipment, the predictive maintenance solution needs further components from the complete technology stack such as communication networks, an IoT platform for data processing and storage, and software applications for advanced data analytics.

Predictive maintenance may utilize various technologies for non-destructive testing to evaluate the condition of equipment, such as infrared, acoustic, vibration, sound, oil analysis, and others. It is also common to combine the data on equipment with data on process performance that is measured by other devices. Wireless sensor networks are often set up to reduce the wiring cost. The IoT platform can be onsite or in the cloud, depending on what the customer needs, which comes with different price tags.

Apart from the technical ingredients of the IoT solution, the investment for the predictive maintenance solution must also cover the necessary transition costs. This includes, among other things, the updating of processes and work instructions, skill development, and Change Management.

RETURN

Adoption of predictive maintenance may result in significant cost savings for maintenance activities, savings in quality costs due to fewer production defects from degraded equipment, and considerably reduced unplanned downtime which translates into higher system availability.

To quantify the return, these effects are integrated into an overall model that links the different impact chains and then specifies the dependencies in mathematical form. The details of the impact model and also the required granularity will depend on the specific situation. However, the model will always be structured around indicators that capture the performance of the relevant business process.

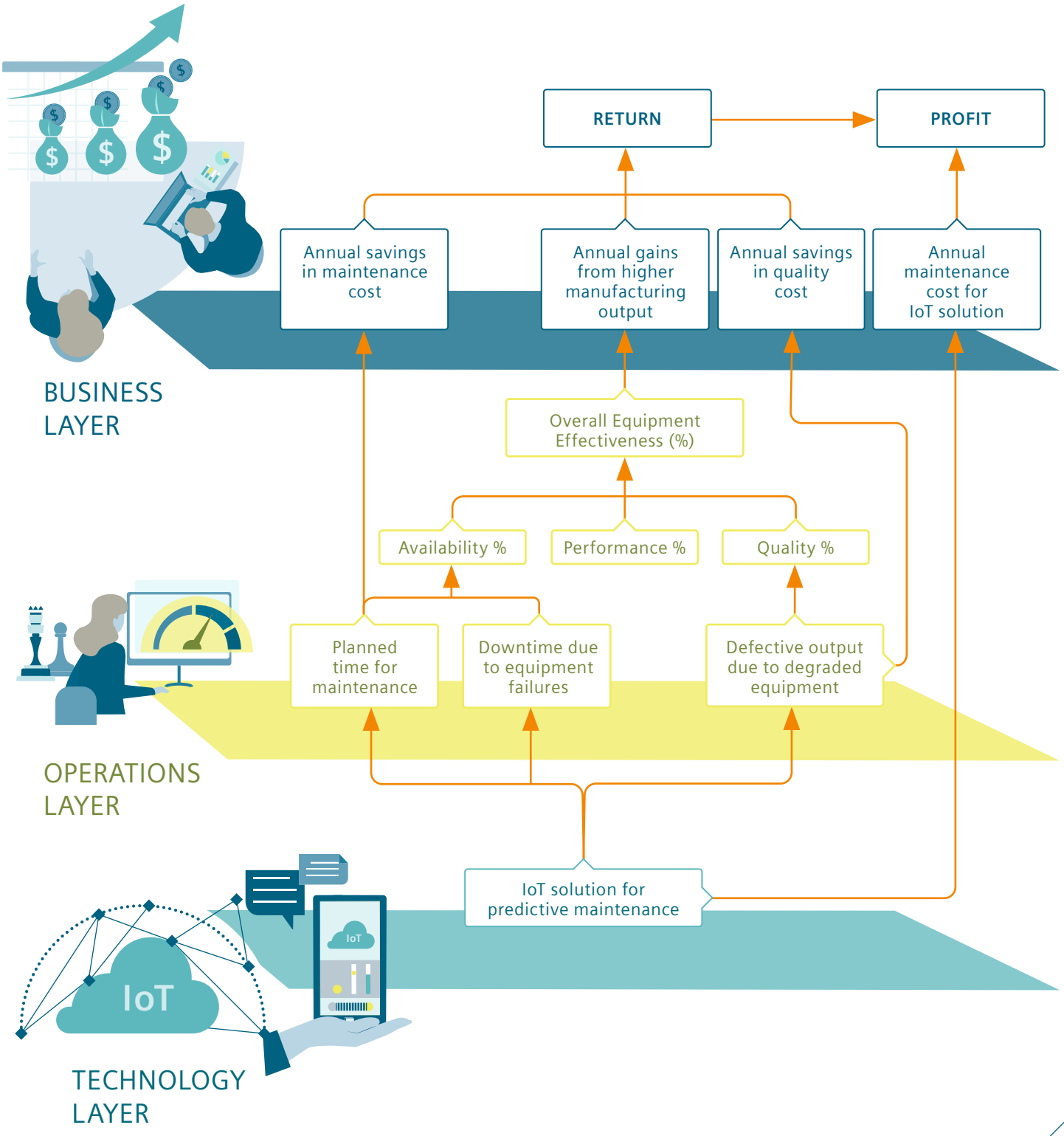
Here the model of impact chains unfolds around the Overall Equipment Effectiveness (OEE), which is an established industry standard for measuring manufacturing productivity. OEE identifies the fraction of manufacturing time that is truly productive and is defined by

OEE = (AVAILABILITY) * (PERFORMANCE) * (QUALITY)

An OEE score of 100% means the manufacturing process produces only good parts (100% Quality), as fast as possible (100% Performance), with no downtime (100% Availability).

Predictive maintenance promises savings in maintenance cost, increased system availability, and reduced quality cost.

The sum of savings and benefits from the impact model determines the return. Be sure to subtract the annual costs for maintaining the predictive maintenance solution to determine the profit, which then goes into the ROI calculation.


RETURN
PROFIT
Annual savings in maintenance cost
Annual gains from higher manufacturing output
Annual savings in quality cost
Annual maintenance cost for IoT solution
BUSINESS LAYER
Overall Equipment Effectiveness (%)
Availability %
Performance %
Quality %
Planned time for maintenance
Downtime due to equipment failures
Defective output due to degraded equipment
OPERATIONS LAYER
IoT solution for predictive maintenance
IoT
IoT
TECHNOLOGY LAYER

HANDLING UNCERTAINTY IN ROI CALCULATIONS

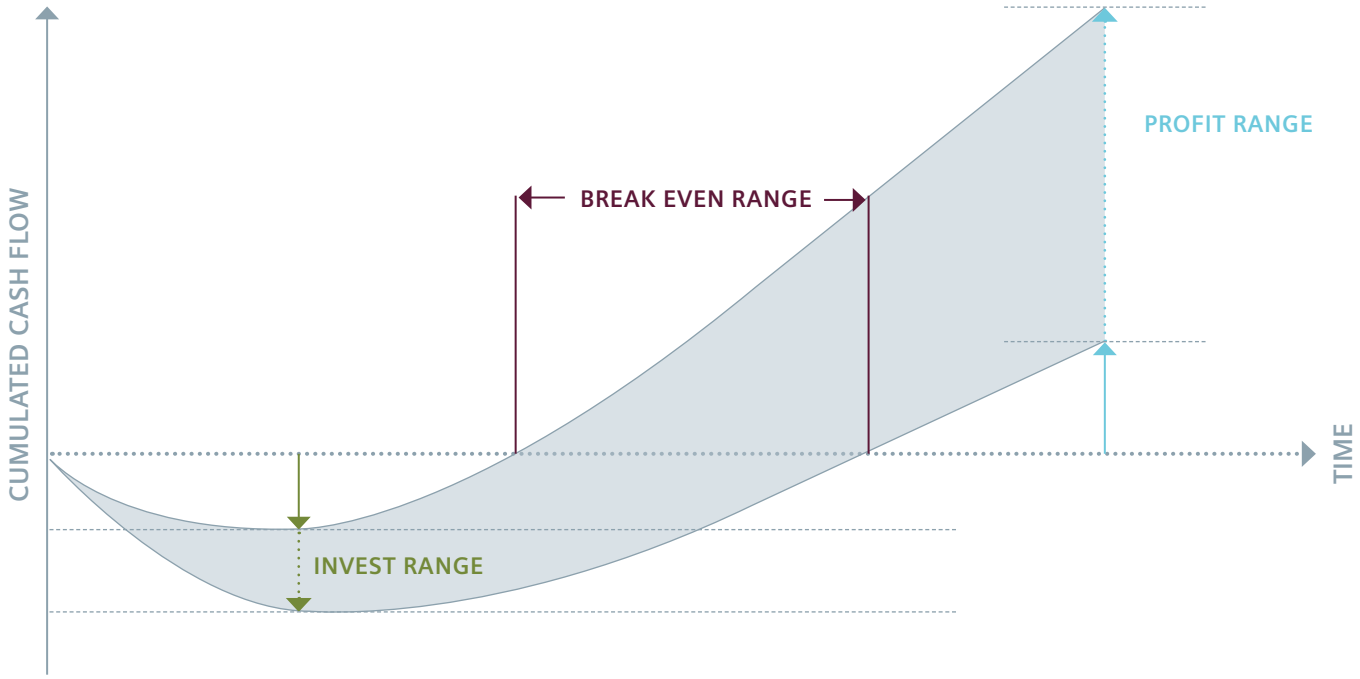
As the world is not deterministic, and new technologies are difficult to predict, uncertainties should always be considered in ROI calculations.

This is true for the invest as well as for the impact model. Keep in mind that data always reflects the past, and there is no guarantee that things won't change in the future. Also, available data always represents a sample, which leads to confidence ranges depending on sample size and potential inaccuracies due to sample bias.

Uncertainties lead to a probability distribution for the calculated ROI.

In practice, the dependencies between the parameters in the impact model often can't be determined empirically due to missing or inadequate data. So, they must be estimated by experts. This adds even more uncertainty into the equations.

That said, realistic ROI calculations should never yield a single number, but always result in a range of possible or likely outcomes. How does this situation affect our approach to calculating the ROI of an IoT initiative?



To begin with, the approach as such does not change at all. But where we were thinking of putting a single value into an equation before, we must now consider specifying an uncertainty range instead. We recommend using a spreadsheet to capture the relevant parameters and their dependencies and add the corresponding uncertainty ranges. Using statistical simulation techniques, uncertainty ranges for the individual parameters can be translated into probability ranges for the results of the business case calculation.

In our experience, people rarely believe an exact number for the estimated ROI of an improvement initiative if the calculation relies on various assumptions and unclear estimates. If the calculation scheme explicitly handles uncertainty ranges including conservative estimates, however, then the credibility of the business case dramatically improves.

Including uncertainty in the ROI calculation increases the credibility of the results.

EXTREME UNCERTAINTY

How to proceed if the uncertainty is so large that it does not allow any conclusion about the eventual return on the proposed investment?

- Traditional methods to calculate ROI based on discounted cash flows are not the best choice for emerging technologies, which are associated with extreme uncertainty and might lead to business disruption. These methods do not value the importance of long-term strategic investments.
- When an investment is strategic, it is implicitly accepted that there will be no measurable return in the short term. In this case, one should not talk about the ROI of the investment.
- An alternative approach in this situation might be to value the investment as a real option, i.e., analogous to a financial call option.[6]
- When using the real options method to evaluate an investment in a new technology, the cost of the initial investment is the price paid to obtain the set of future call options. This concept is not new as companies routinely invest in new technologies hoping to leverage innovation by developing new products later.

KEY RECOMMENDATIONS

Most companies struggle to quantify the return of their IoT initiatives. Business leaders rightly demand credible answers before making decisions about investments in IoT technology. This paper describes a systematic approach towards meeting this target and identifies the ingredients for the ROI calculation. These are our key recommendations to consider when following the outlined path.

1

IF IT DOES NOT SUPPORT YOUR BUSINESS – DON'T DO IT

When considering how IoT can transform your organization, remember that the technology might be exciting and new, but it needs to serve the business, not the other way around. When investigating the ROI of an IoT initiative, the IoT solution defines the invest, and the business problem defines the potential return.

2

CALCULATE ROI BASED ON CASH FLOW

ROI measures the gain or loss generated on an investment over a period relative to the amount of money invested. The profit over the period is the difference between the discounted cumulated cash inflow and outflow. This approach is viable in most situations, including investments in new technology provided the uncertainty is manageable. If you are investing for strategic reasons and there is no expected return in the near term, alternative approaches such as real option values might be preferable to evaluate an investment.

3

DO NOT FORGET TRANSITION COSTS WHEN PLANNING AN IOT INITIATIVE

While everyone is concerned about the technology stack, the digital transformation requires far more than just implementing a new technology. It is the change and adaption of the organization to the new technology that makes it a success story. The investment budget for an IoT initiative must cover the costs for technical issues, and also non-technical issues such as process adaptations, skill development, and Change Management.

4

MODELLING IMPACT CHAINS IS THE BASIS FOR QUANTIFYING RETURNS

The return of an initiative is calculated by evaluating the impact on the indicators describing the business processes of interest. The estimated changes of these indicators are then translated into financial KPIs for the ROI calculation. Modelling impact chains is an interdisciplinary exercise that involves business managers and domain experts. Joint workshops help managers to better understand the challenges on an operational level and domain experts to recognize the critical business issues.

5

MONITOR THE RIGHT INDICATORS TO FIND OUT WHETHER THE INITIATIVE PAYS OFF

The need to demonstrate measurable results is not unique to an IoT initiative. Throughout history, this has been mandatory for any business improvement program. Indicators monitor whether an approach is working and whether it delivers the expected results. The decision of what to measure helps companies stay focused on optimizing the business processes that add the most value.

6

CONSIDER UNCERTAINTY IN ROI CALCULATIONS TO INCREASE CREDIBILITY

IoT initiatives are often navigating uncharted territory. Statements about the expected returns will necessarily rely on more or less plausible assumptions and expert estimates. In situations like these, it is hard to believe an exact number for the estimated ROI. The credibility will significantly increase, if the calculation explicitly handles uncertainty ranges in the impact model.

Each IoT journey is unique. Driving a successful IoT implementation requires both technology expertise and an understanding of the business situation.

Many companies will look for partners with competencies in IoT technologies and experience with business process optimization as well as Change Management approaches.

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ABOUT SIEMENS IOT SERVICES

The IOT Services unit is part of Siemens and was founded April 1st, 2019 with its headquarters in Munich to offer customers end-to-end solutions for their digital transformation. With more than 7,000 employees in 10 countries and 21 offices, the unit offers a global network of employees to implement projects of various scale – from project-based IoT consulting to a fully digitalized organization.

Further information is available online

www.siemens.com/iot-services

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THANK YOU

To all contributors for their time and insights

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