

# THINK ACT

BEYOND MAINSTREAM



## Smart strategies for smart sensors

Capturing value in next-generation technology

February 2017



## THE BIG

# 3

## 17%

Unit sales of sensors are growing rapidly, with a forecast 17% CAGR through 2020.

Page 3

## -8%

However, the average price for sensors is set to fall around 8% a year between 2010 and 2020.

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## 3x3

We identify 3 player archetypes and 3 strategic options.

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# Sensors are plagued by price deterioration and commoditization. Players need smart strategies in order to keep a larger slice of the cake for themselves.

Demand for sensor technology is rapidly expanding. Smart sensors lie at the heart of modern technology – from inertial navigation systems in cell phones to object-detecting driver assistance systems. The much-trumpeted Internet of Things, combined with increasing automation in vehicles and smart wearable systems for health monitoring, is ensuring robust growth in unit demand for sensors. As a result, unit sales of sensors rose from 6 billion in 2010 to 16 billion in 2015. And industry pundits are forecasting unit sales of almost 30 billion by 2020 – a CAGR of an impressive 17 percent.

But there's a catch. Despite being essential high-tech components, sensors are facing continuous price deterioration and commoditization. The prices of sensors are falling sharply as a result of factors such as

competition between suppliers and increasing demand for low-cost minimum viable products in new high-volume consumer electronics applications.

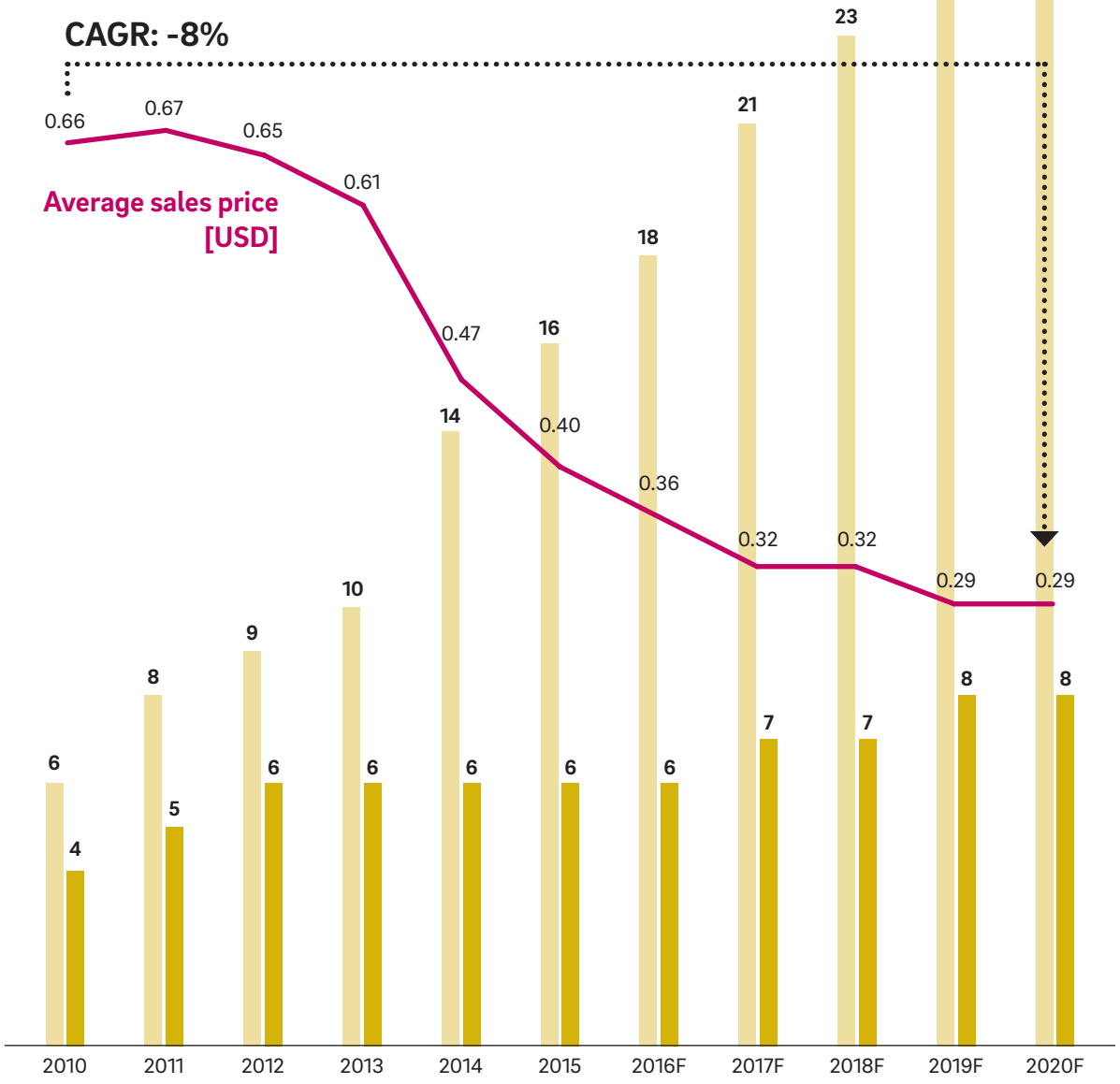
This downward pressure on prices is not likely to let up any time soon, either. Average sales prices for sensors have fallen consistently over the last five years and will continue on this downward trajectory through 2020, with a forecast CAGR of -8 percent. Clearly, the pressure is on for sensor manufacturers to act. → **A**

Achieving sustainable profit in this industry is a challenge. Sensor manufacturers currently capture only a fragment of the value of the applications that they make possible in the first place. These players need to figure out a way to keep a larger slice of the cake for themselves rather than seeing it swallowed up by actors further downstream. Due to their nature,

A

# UNIT SALES AND REVENUES ARE GOING UP AND UP...

...but every silver lining has a cloud



Units [bn] Sales [USD bn]

CAGR: Compound annual growth rate

Source: IC Insights; Roland Berger

smart sensors are typically tailored toward specific applications and, as such, are specialized products. As a result, large established players cannot purely rely on an economies of scales approach through standardized products to cater to the smart sensors market across industries and applications. The makers and providers of products and services that use sensors – cell-phone manufacturers, healthcare device companies, and the like – need to decide if they should integrate vertically or not. And digital leaders such as Google and their peers must figure out where exactly to position themselves in the value chain in order to maximize profits. Whatever type of company you are, you need smart strategies to ensure the profits keep rolling in as the market chops and changes.

Some players have figured out a way to do this effectively. While intently looking at the market, its drivers, and the players therein, Roland Berger has identified companies that act successfully and create value. By way of example, let us take a look at a few of these best practice cases:

Swiss electrical measurement specialists LEM, the world market leader in Hall-based current sensing, is achieving success by focusing on measurement quality for industrial and automotive applications, at the same time as reducing size and costs. The Israeli company Mobileye, producer of advanced driver assistance systems (ADAS), has found success through low-power, inexpensive computing platforms running a sophisticated object-recognition algorithm based on artificial neural networks that meet automotive qualification requirements. Even the US giant Amazon has captured part of the smart sensor value chain with the introduction of the Echo, which includes a CMOS-integrated microphone array that connects directly to its cloud-based Alexa Voice Service.

These champions – and they are by no means the only ones out there – have identified strategies that, crucially, are in line with their core competencies and reflect their specific situation. The challenge for every player in the smart sensor industry is to find a way to do the same, in a systematic and effective manner.

Below we present our take on what companies must do in order to participate in the growth of the market and avoid losing out as a result of commoditization. Our approach takes companies through a series of logically ordered steps: Understand yourself better, consider your strategic options, then select the strategic move that suits you best as an organization. Developing a smart strategy is no easy matter. But we believe that by following our systematic approach it is possible for players of all types to effectively master the complexity.

# Find yourself: To identify the right strategic move, you first need to work out who you really are.

We have designed our industry framework, analyzed companies' current product offerings, technologies and competencies, and identified three key player archetypes.

How can companies in the Internet of Things value chain capture maximum value from sensors? The first task is to identify what sort of company you really are. We have developed a specific approach that provides insights into the different sorts of players out there. On this basis we have identified three archetypes.

We start by defining the overall framework or architecture for sensor applications. We do this by looking at the various requirements for the different applications of sensors and grouping these requirements into six separate clusters.

Let's look at some examples. One of the clusters of requirements that we have identified is *Special environmental constraints*. We call this Cluster 1. Sensor applications subject to these requirements must be reliable, suitable for use in special environments, energy-saving, or compact. Applications subject to the requirements of Cluster 4, *End-user convenience*, must ensure data security, accessibility or usability, or allow multi-platform usage. Applications subject to the requirements of Cluster 6, *Remote analytics*, must permit multi-device input, high computing power and bandwidth, and centralized computing. → **B**

Having established the different clusters of requirements, we can now construct our framework. We illustrate this as a spiderweb with six points - each point represents one cluster of requirements. → **C**

The next step is to take a close look at companies' current product offerings, technologies, and competencies, and map them onto our framework. Companies create value in different cluster areas to varying extents. For example, a company that produces lensless and hence compact smart vision sensors mainly creates value in the areas of *Special environmental constraints*, *Measurement capacity*, and *Local analytics*. Another company may have applications creating a high degree of value in *Remote analytics* and *Communication* and, to a lesser extent, in *Local analytics* and *Measurement capacity*. Mapping the offerings of these companies onto the spiderweb reveals which players create value in which part of the framework.

By mapping a wide range of firms and their offerings onto the framework, we are able to identify three key archetypes. These archetypes are generic types of companies, whose added value is centered on distinct parts of the framework. We call the three archetypes *Measurement Specialists*, *Local Analytics Leaders* and *Digital Innovators* (see box feature on page 9). They represent the typical behavior of different types of players on the market.

## B

# DIFFERENT APPLICATIONS FOR SENSORS HAVE DIFFERENT REQUIREMENTS

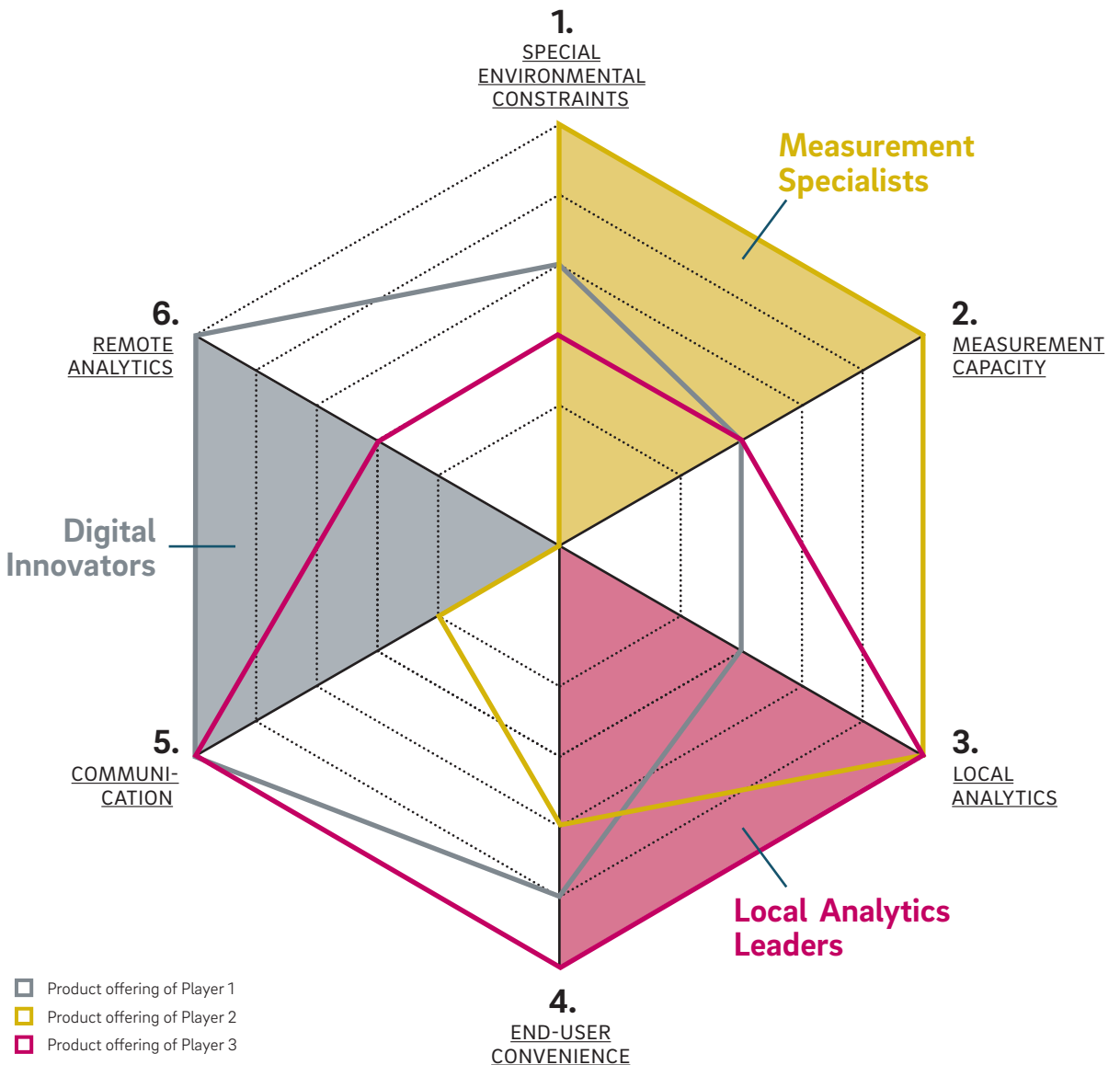
We identify six clusters

<b>1.</b>	<b><u>SPECIAL ENVIRONMENTAL CONSTRAINTS</u></b>	Reliability	Special environment	Energy saving	Compact
<b>2.</b>	<b><u>MEASUREMENT CAPACITY</u></b>	Real-time	Complex	N-in-1 measurement	High sensitivity
<b>3.</b>	<b><u>LOCAL ANALYTICS</u></b>	Data conditioning		Local processing	Self-calibration
<b>4.</b>	<b><u>END-USER CONVENIENCE</u></b>	Data security	Accessibility	Usability	Multi-platform usage
<b>5.</b>	<b><u>COMMUNICATION</u></b>	Secure communication		Wireless communication	Data compression
<b>6.</b>	<b><u>REMOTE ANALYTICS</u></b>	Multi-device input		High computing power	Centralized computing

C

# FIRMS CREATE VALUE IN DIFFERENT PARTS OF THE SPIDERWEB

We identify three key archetypes: Measurement Specialists, Local Analytics Leaders and Digital Innovators





## Measurement Specialists

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Measurement Specialists are usually traditional sensor manufacturers primarily engaged in sensor hardware design and production. As a rule, this type of company focuses on precision and quality of measurement. Their core know-how lies in the area of physical measurement. The products they manufacture are typically able to resist specific environmental conditions, such as high levels of humidity, vibrations, explosive gases, dust, or other potential problems. Often their products are highly durable and have a long lifetime.

Measurement Specialists have a limited focus on end users and specific applications. More often than not they are second-tier or even third-tier suppliers. Their value comes from producing sensors with a high level of measurement accuracy that can perform complicated measuring tasks in difficult environments with outstanding reliability. Depending on the industry they serve, cost pressure may represent a dominant factor in their business.

## Local Analytics Leaders

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Local Analytics Leaders are typically more software-oriented players focused on developing analytics solutions. Typically, they have expertise in specific end applications ("domain knowledge") but limited measurement capabilities of their own. Their know-how lies in analyzing and processing data locally, potentially enabling them to meet the requirements of real-time analysis. Their applications combine multiple sensors or measurements (e.g. local sensor data fusion) and perform complex algorithms on the sensor data to enable value-added functions (e.g. object detection).

Local Analytics Leaders in some cases have direct contact with end users. Their value comes from performing local analytics in a reliable fashion and providing those analytical functions to customers as a ready-to-use feature. This makes them indispensable in situations where customers require these advanced functions while meeting high reliability requirements, when applications are mission-critical or data needs to stay local due to security concerns.

## Digital Innovators

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Digital Innovators usually focus on processing large amounts of data on their own network of servers. Their products are in most cases part of larger platforms. Of the three archetypes, they are the furthest away from the physical layer.

Digital Innovators have direct access to end customers. They place a strong focus on integrating different services

to increase usability. Their core value lies in combining multiple standard sensors, analyzing and visualizing the data they generate to offer a particular feature or function. They typically derive most of their value add from large amounts of data and constantly innovate their analytics solutions, e.g. they are the major drivers behind modern techniques such as artificial neuronal networks.

# Three strategic options exist in the field of sensors. Which is the right one for you? That depends on your application markets. But it might be time for a change of direction.

Just as we have identified three archetypes for companies on the market, we have also determined three broad strategic options. These strategic options follow on directly from the archetypes – indeed the archetype represents the starting point for any strategic shift. Companies need to decide whether to stay where they are at the moment, or if they can capture more value by repositioning themselves in one of the other two areas.

We call our first strategic option **ANALOG NOW**. This strategy involves focusing on performing measurements while meeting environmental constraints. This is the traditional area of Measurement Specialists

and, if you are a successful player of this type, continuing this strategy may be the right choice for you. Your core competency may lie in translating physical principles to new, often semiconductor-based solutions, and producing highly robust sensors, for example, and this is exactly what your customers need for their applications. Companies pursuing this strategic option typically face strong cost pressure in their business and target either high volume or very special niche markets.

The second strategic option is **SMART PLUG & PLAY**. Companies pursuing this strategy generally fo-

cus on local processing and end-user convenience. This is the domain of Local Analytics Leaders, whose core competences lie in processing sensor signals to provide out-of-the-box advanced functions. Success lies in having unique expertise in choosing the right algorithms depending on the problem to be solved, and processing signals in the right way by applying relevant domain knowledge. This allows them to create convenience for customers, or alternatively to provide added value to customers by supplying them with a ready-to-use "black box".

Depending on the application and types of sensors, the Smart Plug & Play option may not require ownership of the physical sensor. This option is therefore a valid strategy for players able to provide unique advanced processing know-how but who do not themselves own or produce any sensors.

The third strategic option in our analysis is large-scale **SENSOR FUSION**. This approach involves focusing on cloud communication and multi-sensor or multi-device data processing. This option is the realm of Digital Innovators. Successful players are able to establish a communication network – either their own network or a network belonging to a third party – that is compatible with the application's requirements. They also have the necessary know-how to combine large amounts of multi-device, multi-platform sensor data for the purposes of carrying out advanced analytics. Moreover, they know how to prepare data, present it to end-customers visually and offer a uniform software platform allowing the customer to manage their application.

The strengths of players pursuing a Sensor Fusion strategy typically lie in handling Big Data, analyzing it and communicating the summarized results to customers in a visually appealing way. These players operate mainly in the digital world and enjoy direct contact with end customers. This customer proximity enables them to innovate, develop and produce software products successfully. → **D**

In theory all three strategic options are open to all three archetypes. However, the specific requirements of the application markets you take part in define your potential strategic moves. Let's look at an example. For historical reasons you may be a Measurement Specialist pursuing an Analog Now strategy. But now you see that your cameras have become a standard product where only price is important. In this case, if you have

learned how to do object recognition and how to sell it to your customers, it might make sense to shift more toward a Smart Plug & Play strategy.

Alternatively, a Local Analytics Leader or Digital Innovator may want to complement their core strategy with elements of the Analog Now approach. This move could be attractive as ownership of the sensor will provide them with direct access to the data generated or allow them to apply a "smart measurement approach". An example of a company following this strategy is the Israeli start-up Vayavision, which combines computer vision cognition algorithms with LIDAR technology. Vayavision first interprets the scene then only uses LIDAR for parts of it, thus reducing the energy emitted by a factor of three and cutting the costs to a fraction of those of a standalone LIDAR system. Indeed, in our project work we often see pioneering companies strengthening their core competences while tapping into adjacent strategic playgrounds.

What then, are the next strategic steps that each archetype should consider? Which questions should they be asking themselves? We look at the options for each of the archetypes below, including the feasibility – and advisability – of branching out into neighboring strategic areas.

### **STRATEGIC QUESTIONS FOR MEASUREMENT SPECIALISTS**

Measurement Specialists need to consider whether they can leverage their sensor-application know-how to provide local analytics to customers, creating new value in the process, e.g., by improving measurement speed, accuracy, or costs by orders of magnitude. Companies considering a Smart Plug & Play strategy must answer a range of strategic questions: Are they close enough to the end application for this strategy to work? Can they offer additional analytics software? Is there a niche application particularly suited to their core know-how? Can they standardize their products and interfaces and create a modular portfolio? Or can they combine their analytics capabilities with new measurement principles?

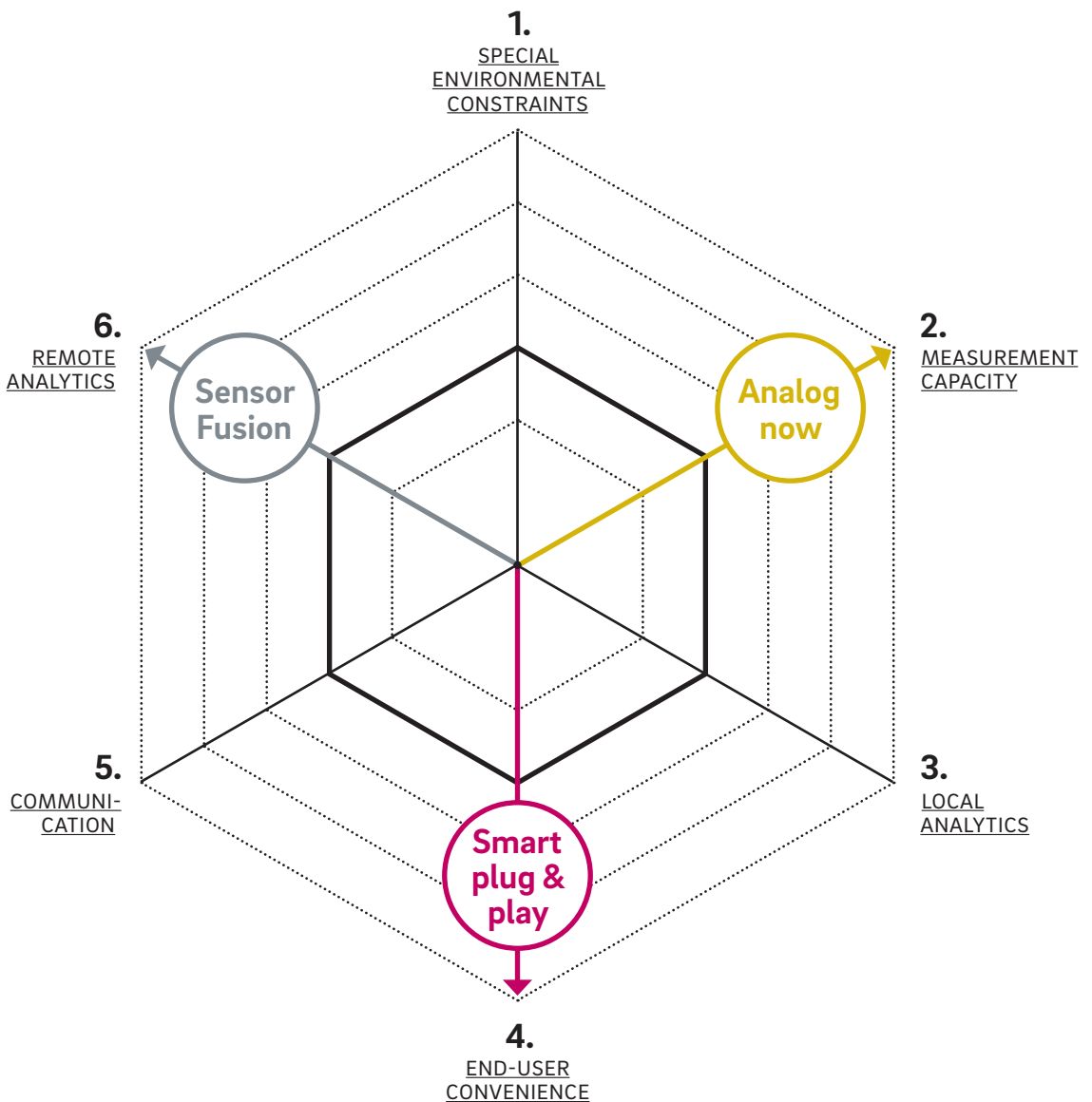
### **STRATEGIC QUESTIONS FOR LOCAL ANALYTICS LEADERS**

Local Analytics Leaders have a number of options open to them. The first, as mentioned above, is to edge into the traditional territory of Measurement Specialists by

# D

## IS IT TIME FOR YOUR COMPANY TO SHIFT DIRECTION?

Three strategic options



developing, acquiring, or sourcing their own sensor hardware. Here, they must ask themselves if doing so would bring them more value add. Would combining tailored software and hardware provide them with a competitive advantage? And do they in any case have the necessary integration competence?

Alternatively, Local Analytics Leaders could choose to go digital. To decide whether this would be a good option for them, they need to ask themselves whether moving into the cloud would actually make their products more efficient or cheaper. Would gathering and analyzing data from the entire installed base (all their products, potentially for all customers) give them a competitive advantage in terms of optimizing the application, improving statistical analysis, or potentially developing new applications and business models?

A third option for Local Analytics Leaders is to stay in the middle, concentrating on their core competences – applications where remote analytics do not provide any value add or cannot be used due to environmental constraints. In this case they should ask themselves whether they can use their core competences such as specialized algorithms in other fields. Can they diversify? Can they standardize or generalize their products so that they can be used more widely? Can they gain a competitive edge by offering convenient standardized interfaces so Digital Innovators can use their own analytics know-how? Or should they continue to provide functions to customers via a convenient black box, where the customer neither needs nor indeed wants to know how the packaged application does what it does?

## STRATEGIC QUESTIONS FOR DIGITAL INNOVATORS

Three options also exist for Digital Innovators. If they are considering moving into the hardware world, they should ask themselves what they stand to gain: Improved data quality? More data? The chance to establish a closed propriety platform? Critically, they must determine whether the move will open a fresh revenue stream or they will be subsidizing it in order to fuel their digital business.

The second option for Digital Innovators is to head into local analytics. Here, players must ask themselves

whether they can bring value add to the application, for example by reducing the complexity of the task or providing superior analytics know-how in specific environmental conditions. The critical questions are: Can I expand into new applications by fulfilling the requirements that only local analytics can provide? And can I grab value by doing so?

Finally, Digital Innovators have the option of staying where they are. That doesn't mean doing nothing, of course. While focusing on their core area of expertise they can develop superior analytics or data-gathering software and services. Not only that, they can provide a standardized streamlined platform and interface for customer interaction (APIs<sup>1</sup>), supplying a full ecosystem and leveraging the mass market through standardization. Depending on their market and strategic positioning they can increase customer retention through closed proprietary platforms or increase market penetration through platform openness or open sourcing of core IP. Furthermore, they can build on publicly available data and provide interfaces for data integration. Also, Digital Innovators can expand into additional applications that do not require application-specific know-how. They can move up the value chain, offering professional services or consulting. In addition, they can target maximum economies of scale. They can try to catch customers through their proprietary platform, APIs or interfaces. Or they can become innovation leaders, potentially making parts of their intellectual property open source faster than others can keep up with.

<sup>1</sup> Application programming interfaces, or sets of standardized and easily accessible building blocks or functions that allow a program's internal algorithms to be used on a more abstract level. APIs facilitate re-usage and reduce complexity for users.

# What should your next strategic step be? Understanding yourself and the world around you is the key.

The multiple pressures on the rapidly expanding sensor market make it crucial for the manufacturers of smart sensors to find a way to capture a larger share of value for themselves. At the same time as the providers of the products and services based on sensor technology are questioning what their next strategic step should be, digital giants such as Amazon are making bold leaps into new territory.

To master the complexity, players need to arrive at a proper understanding of who they are. Discovering your archetype – Measurement Specialist, Local Analytics Leader or Digital Innovator – helps limit the range of strategic moves theoretically open to you. It points you in the right direction and suggests what questions you should be asking yourself.

The smart sensor market is in a state of flux. Over time we foresee a shift in value from Measurement Specialists to Local Analytics Leaders and ultimately to Digital Innovators. But we also strongly believe that a role will remain for all three archetypes.

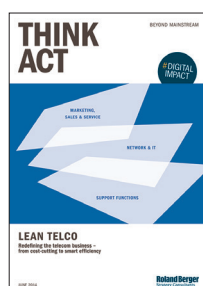
Clearly your next strategic move will depend on your individual situation. Looking at a wide range of examples from industry and finding out where you are positioned on the spiderweb can be very helpful for

making the crucial decision about where you want to head next. Understanding yourself – and the world around you – forms the basis for developing your personal smart strategy and responding to the growing pressure to act. ♦

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