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Digital Innovation & IoT I Europe I 2021

Open Digital Platforms for the Industrial World in Europe 2021

SITSI® I Vendor Analysis I PAC INNOVATION RADAR

Open Digital Platforms for Cloud-centric Industrial IoT

– Positioning of Siemens –

Lead Analyst:

Arnold Vogt

PAC, July 2021

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Author: Arnold Vogt (avogt@teknowlogy.com)

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PAC INNOVATION RADAR GRAPH

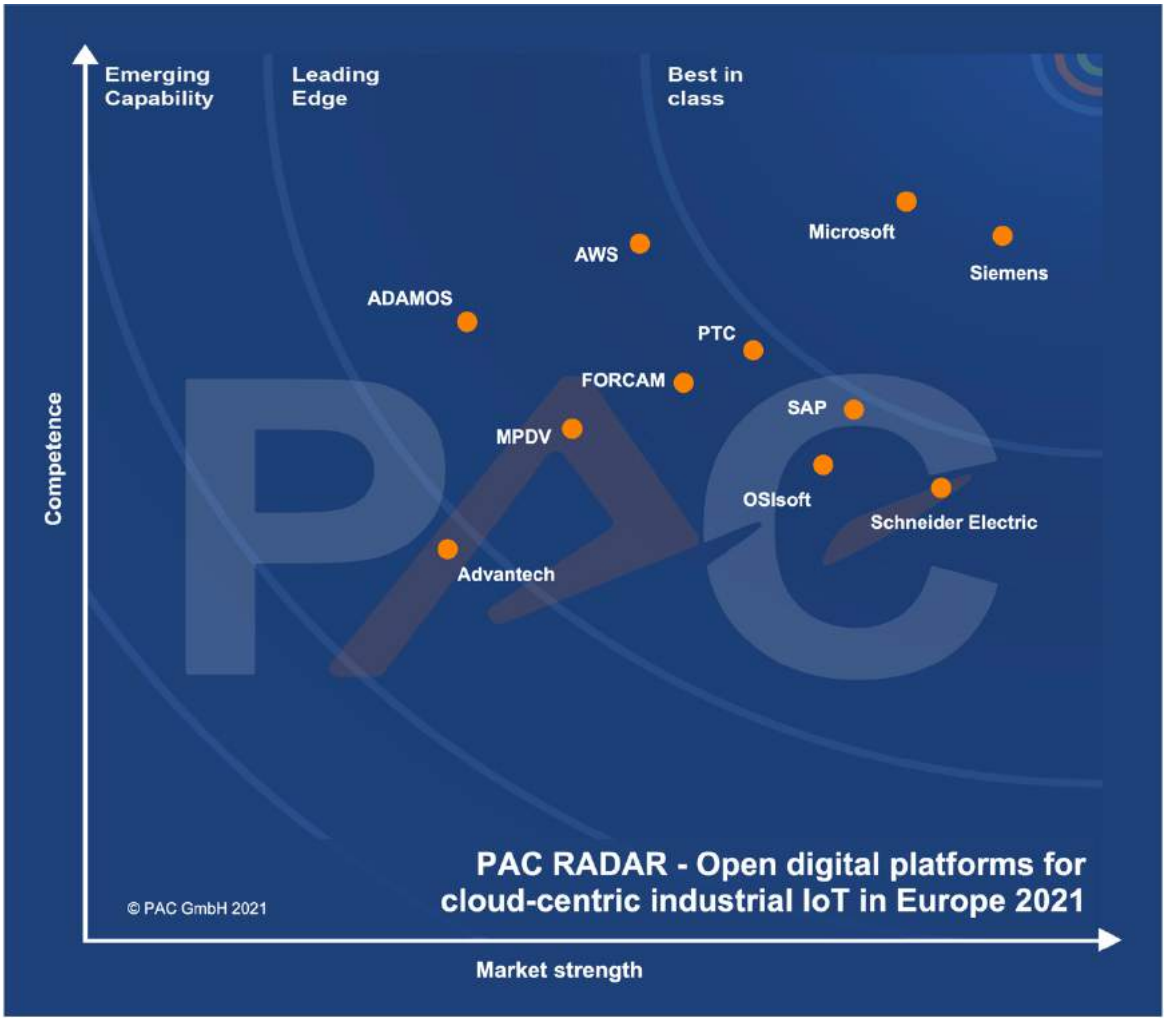

Fig. 1: PAC INNOVATION RADAR graph

INTRODUCTION

Lessons learned from the first wave of industrial IoT projects: agile and efficient scaling is key

Before COVID-19 hit the world, many digitalization projects were initiated and driven forward to take the level of digitization in many factories around the world to the next stage. This first wave of projects was especially driven by the following four factors:

- New digital technologies such as Internet of Things (IoT), artificial intelligence (AI), augmented reality (AR), 5G, and cloud computing reached the factory floor. Each individual technology, but also the potential value derived from combining these new technologies, attracted a lot of awareness in the market.
- Based on the technologies mentioned above, many new use cases (e.g. remote machine monitoring, fleet management, predictive maintenance, connected workers, and digital quality control) became a subject of public debate, promising significant value creation potential through efficiency gains in the production environment and around industrial field services.
- Enthusiasm among innovators and industrial pioneers, who predicted that even more use cases would be possible based on these new technologies and, in addition, these new use cases could potentially create even more value. This led to huge expectations across the industrial world, especially at all management levels. There was a common perception that digitization projects in the factory would lead to immediate efficiency gains in the double-digit range.
- The above-mentioned enthusiasm among digital leaders put a lot of pressure on all other players in the market to follow suit. These followers felt a significant competitive risk of falling behind by doing nothing, or just by moving too slowly.

Ultimately, new technologies, new use cases, enthusiasm, and competitive threats led to a "high sense of urgency" for digital factory projects. Driven by these factors, many companies learned quite similar lessons: First of all, many potential use cases are thinkable. Second, technology is typically not the main problem. Many use cases are technically feasible. While this finding may not have come as a big surprise, the third lesson learned was definitely more interesting, but in a negative way. They often realized that individual use cases generated a more limited return on investment (RoI) than expected. Digitalization projects often do create value, which, however, not necessarily lives up to the high expectations. This created some level of disappointment and disillusionment on the user side of the market.

In summary, we are in a good position today to learn some valuable lessons from the first wave of digital factory projects in the market:

There is no "killer app" on the horizon that enables significant efficiency enhancements (double-digit). Instead, many different use cases allow step-by-step improvements for

industrial companies. We expect further use cases to emerge in the future, but we do not expect to see a killer app.

Manufacturing companies need an efficient approach (e.g. low code) to develop simple new applications for new use cases at a fast pace.

The digital factory requires efficient scalability (simple and fast) to transfer successful PoCs of newly developed applications to many different machines, production lines, and factories.

Agile application development and agile scalability have to be combined with agile application management to handle updates (new functions, security) as efficiently as possible.

In short, there is a need for an agile DevOps approach to manage the digital factory as efficiently as possible. Dedicated platforms can help provide all these capabilities in an efficient and integrated way.

“In a high-speed world, no individual application creates a lasting competitive advantage – it is the ability to move faster on a large scale that makes the difference. This is also true for the digital factory. There is a clear need to develop, scale, and manage industrial IoT applications in a more agile and efficient way.”

Arnold Vogt, Head of Digital Innovation & IoT at PAC.

Lessons learned from COVID-19 – be better prepared for sudden shifts in production

The pandemic has not only revealed the vulnerability of supply chains, but also that of factory operations. Massive shifts in demand, triggered by events like COVID-19, have become a realistic scenario all of a sudden. This means that manufacturing companies have to be prepared to shift their production capacities even to totally different products that would normally be outside their scope – for example, from alcoholic beverages, fashion, or washing machines to hand sanitizer, face masks, and ventilators. COVID-19 has triggered a shift in mindset in factory automation. In addition to production efficiency, agility is becoming much more relevant. This will lead to more investments into agility-enabling technologies such as IoT (internet of things), AI (artificial intelligence), robotics, edge computing, AR (augmented reality), and 5G. An example are digital platforms that allow the efficient and agile sharing of programming code between different IoT-connected machines (e.g. machine tools). This gives factories more agility and efficiency, and a shared, cross-company industrial cloud can even be used to exchange applications across company boundaries.

Market outlook for key topics in IoT – the hype is over, but growth continues

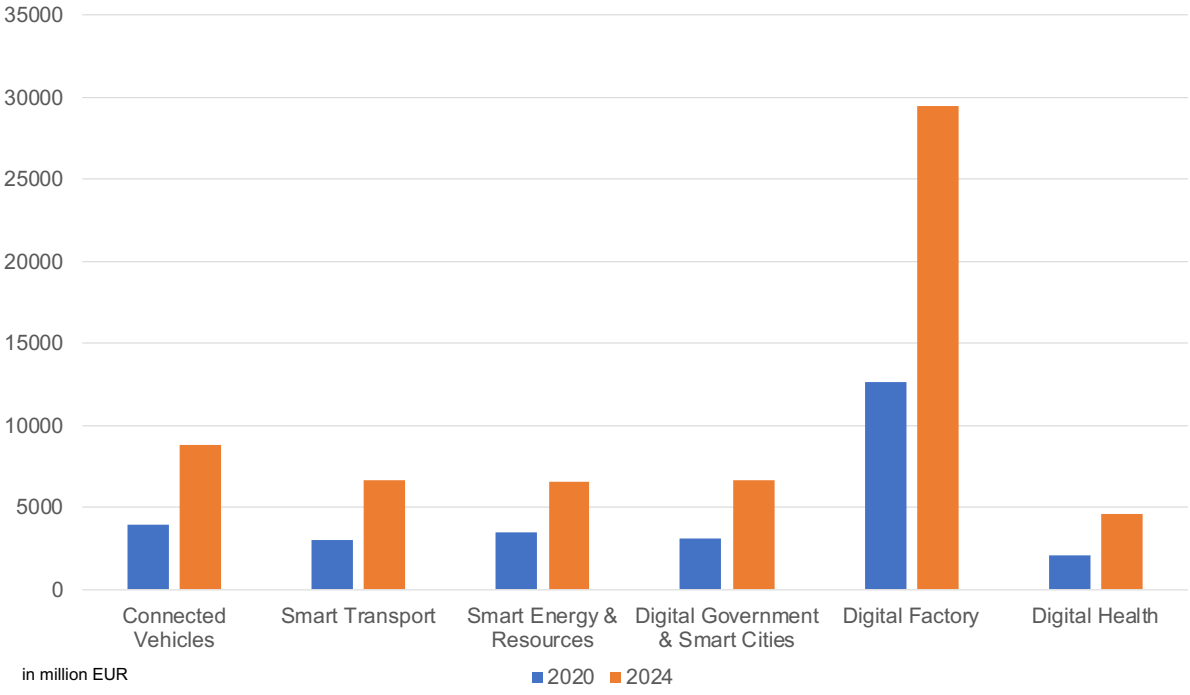

Fig. 2: IoT market size by IoT contexts in Western Europe, 2020 & 2024

MARKET SITUATION

PAC believes in the vision of an open app store for the industrial world; this is why we evaluate the vendor landscape on the path towards this vision. While the vision is straightforward, the evaluation is more complex, as vendors currently follow different approaches to realizing it – cloud-centric, edge-centric, or edge cloud-centric models. The balance between edge and cloud computing distinguishes the different concepts from each other. Before evaluating the vendor landscape for one specific concept, it is important to understand the different concepts.

The emergence of edge computing allows companies to reconsider the best basic architecture for their digital factory and other operational environments. Edge computing plays an important role in this respect. It is not a new technology in itself, but it opens up new perspectives in terms of different architectural concepts. Edge computing can be seen as a competing concept to the cloud world. However, in reality, the two models are often closely connected. PAC strongly believes two things: first, the future of the digital factory is hybrid (edge and cloud together), not pure cloud or edge. Second, even in a hybrid future, different concepts will compete in the market.

The “industrial cloud” concept is not a “cloud-only”, but rather a “cloud-centric” concept. The idea is to bring data from industrial devices at the edge to the applications in the cloud for central data processing. This means that the cloud acts as the central hub for all data (including data management, access, and storage). In addition, the cloud acts as the central hub for all applications (including the app store). However, this does not mean that all applications exclusively run in the cloud. We also observe the extension of the cloud-centric concept to enable some data processing at the edge, albeit tightly integrated and controlled by the cloud. AWS Outposts is a good example of this. AWS Outposts enables edge data processing but is not designed to act independently from the cloud (Outposts needs connectivity to the cloud at least every 6 hours). The big advantage of the cloud-centric concept is speed of innovation around developing, scaling, and managing applications.

Similar to the industrial cloud concept, the industrial edge concept is not an “edge-only”, but rather an “edge-centric” concept. The idea is to bring applications to the data at the edge for local data processing. This means that the edge acts as the central hub for all data (including data management, access, and storage). It does not mean that data storage takes place exclusively at the edge. The cloud may also act as an extended data store, but in an edge-controlled setup. While applications run at the edge in this concept, the related app store can operate in a private back end (edge, data center, private cloud) or in the public cloud. These central app stores enable users to download relevant applications to the edge (just like the cloud app stores from Google or Apple enable the download of apps to smartphones). In this

setup, IoT devices do not directly communicate with the cloud, only via the edge. This enables an edge-controlled system with local data management and data processing plus extended data storage in the cloud. The Siemens edge management system is a good example in this context. When data management and processing take place at the edge, low latency, data sovereignty, trust, and vendor independence are certainly advantages of this concept.

The two concepts described above – cloud-centric and edge-centric – have a clear focus on today's requirements of the digital factory. However, when companies consider choosing a concept today, it is highly recommended that they do so also with the future in mind. This means considering further requirements that are expected to arise soon. It is pretty obvious, in our high-speed world, that tomorrow comes ever faster. So what should companies take into consideration? Thanks to the latest innovations in the cloud world, we can predict what the next wave of "cloud-native" innovations will bring to the industrial edge (and the data center). Kubernetes will be the next big thing at the edge, as it already is in the cloud. Kubernetes is a highly automated approach to managing and scaling a large number of containerized applications across clusters of distributed infrastructures (called nodes/pods). The basic aspects of the edge cloud-centric concept are quite similar to the industrial edge concept, with one addition – Kubernetes manages the edge applications. Kubernetes takes scalability at the edge to a new level and helps to overcome the challenge of edge scalability. Another big advantage of Kubernetes is multi-cloud. This means that Kubernetes can go beyond the efficient management of edge infrastructures and also integrate cloud infrastructures from different providers. Kubernetes-based multi-cloud is therefore an efficient way to manage cloud vendor dependence and edge scalability.

Market trends & insights

While vendors in most cases prefer one concept (as described above), we observe that some of them have started to adopt different concepts in parallel to stay flexible enough to adjust to different client preferences. This creates some internal competition within these vendor companies, but it is usually possible to identify their focus offering (offense play) and their "me too" offering (defense play).

The vendor landscape mainly comes from two different backgrounds – cloud infrastructure-centric and application-centric. On the one hand, there are horizontal cloud platform providers (hyperscalers such as Microsoft and AWS), which increasingly position themselves as industrial cloud platform providers together with their ecosystems of industrial application partners. On the other hand, there are providers of industrial IoT platforms (e.g. Siemens MindSphere, PTC ThingWorx) and industrial software (e.g. the MES solution FORCAM FORCE), which increasingly offer their own industrial applications via the cloud, complementing them with more and more industrial software solutions from 3rd parties

on an integrated technology layer. This approach can be described as the “Salesforce model”, building a strong cloud application ecosystem around a strong core application.

We added Schneider Electric with its Schneider Electric Exchange Shop as a new relevant player. While the number of applications available on their marketplace is impressive (around 160), it has mainly been a catalog so far, not a real app store. However, we expect this to change in time. This is a typical pattern that we observe in the evolution towards an app store – a marketplace starts off as a basic catalog and increasingly evolves into an app store with direct payment and deployment functions.

Important capabilities of leading platforms

The aim of cloud-centric industrial IoT platforms is to provide many different cloud-based IoT applications (delivered in SaaS mode) from an open ecosystem of partners via an app store model. Two things are important to realize this vision. One aspect is technology-related: open connectivity to all types of industrial devices and fast integration with cloud applications. This setup is designed to enable clients to connect their industrial devices to the cloud and to different relevant cloud applications. Ultimately, this includes an application marketplace that is well-structured and allows direct purchase and provisioning of applications (not just a catalog). The second aspect is partnership-related: an open platform combined with a strong ecosystem of application development partners gives users fast and easy access to diverse and innovative applications, enabling them to boost the operational efficiency of their connected devices. If a strong application development partner ecosystem does not exist yet, a strong client base will help to create one. Vendors that have an established client base around industrial hardware (installed base of machinery and equipment) and/or industrial software (e.g. industrial core applications such as MES) have a clear advantage in building a robust application partner ecosystem as their partners enjoy the benefit of selling to an existing user group.

Leading vendors

From PAC's perspective, Microsoft is the leading player in open digital platforms for cloud-centric industrial IoT. The Microsoft Azure marketplace provides 500+ horizontal IoT applications in a real app store, plus 120+ industrial IoT apps via AppSource (in catalog mode). What's even more relevant, Microsoft is a top ecosystem player in this space. Beside its numerous strategic partnerships with major software vendors for manufacturing (e.g. Siemens, ABB, Schneider Electric, PTC, FORCAM, SAP), Microsoft today strongly focuses on openness (Linux, open industrial standards such as OPC-UA). In line with this, Microsoft launched the Open Manufacturing Platform (OMP) together with BMW in 2019. OMP is a project under the Linux Foundation that aims at defining and using a common open data model. Today, the community has around 30 members from the manufacturing industry (e.g. BMW, ABB, Bosch, ZF Friedrichshafen AG, Anheuser-Busch InBev) and the IT sector (e.g. Microsoft, Red Hat, Reply, Capgemini, Accenture, Cognizant). In addition, Microsoft also joined other initiatives, such as the Open Industry 4.0 Alliance, to drive standards and collaboration. It remains to be seen what the future will bring for the recently announced Microsoft Cloud for Manufacturing, and what level of new focus on the shop floor and industrial applications it will introduce. Since the offering is still a beta version, it has not been included in this evaluation.

The strength of MindSphere from Siemens lies in four aspects – the strong installed base of industrial hardware and software; the integration of MindSphere within the Siemens portfolio, including with Industrial Edge and the acquired low-code application development platform, Mendix; the strong Siemens partner ecosystem; and the MindSphere store, which actually is a real app store and not just a catalog. The MindSphere store has 5 sub-categories (connectivity, access, apps, services, and solutions) with around 150 components overall. The "app category" is by far the largest sub-category and contains around 85 apps. Most of these apps are already available like in an app store, but most apps still come from Siemens itself. Only a minority (around 10 apps) are provided by partners today. To achieve an "open platform", this definitely needs to be enhanced. However, generally speaking, we believe that Siemens is fully embracing the cloud and the app store model. This is underscored by three facts – first, Siemens has slightly repositioned MindSphere, away from an IoT operating system, towards "industrial IoT as a service". Second, the Partner Solution Catalog, which complements the MindSphere app store, includes over 60 partner solutions and use cases. Third, we also consider the growing Siemens PLM store as evidence that Siemens has been pushing to move its own software portfolio to the cloud, increasingly offering it via a marketplace model.

Industrial IoT is one of many topics covered by the huge umbrella of the AWS marketplace. AWS certainly has a strong foundation from which to further expand in this space by establishing more and more

partnerships with industrial application vendors. Today, 80+ industrial IoT apps are available on the AWS marketplace. A key initiative AWS has been driving forward in the industrial space is the strategic partnership with Volkswagen to build a joint industrial cloud with a marketplace for cloud-based IoT applications. The aim is to connect all VW factories (122) to this cloud, also integrating VW suppliers, and increasingly open the platform to other manufacturing companies. While it was a more closed community at the beginning (VW, AWS, and Siemens), in summer 2020, AWS and VW opened their community to new partners. So far, around 15 other companies, e.g. ABB, Wago, BearingPoint, and MHP, have joined the AWS/VW industrial cloud community. While the community is more open today, we believe that the focus still lies on the initial goal – connecting VW factories to the industrial cloud and adding more IoT applications for them.

Being successful with an app store model around industrial IoT remains a challenge for all vendors. This is why we believe that it is critical to explore new concepts to attract manufacturing companies and application providers. An interesting example in this context is ADAMOS. In May 2021, ADAMOS launched a very interesting new approach with ADAMOS STORE and ADAMOS HUB. ADAMOS STORE is an app store, ADAMOS HUB is an integration platform. This offers two distinct advantages to users. First, it separates the underlying technical basis for building apps – the IoT platform – from the app store. This allows clients to combine not only apps based on ADAMOS (powered by Software AG) with the ADAMOS app store; in addition, any other IoT or PaaS platform available on the market can be used. Second, this approach allows clients to integrate with the ADAMOS HUB on different levels, and even provides an integration roadmap, from the first integration level (single sign-on) to deeper integration levels (machine data). In our view, this is a very “open” and adaptable new approach. We therefore consider ADAMOS as a hidden champion in the market today.

PAC INNOVATION RADAR “OPEN DIGITAL PLATFORMS FOR CLOUD-CENTRIC INDUSTRIAL IOT IN EUROPE 2021”

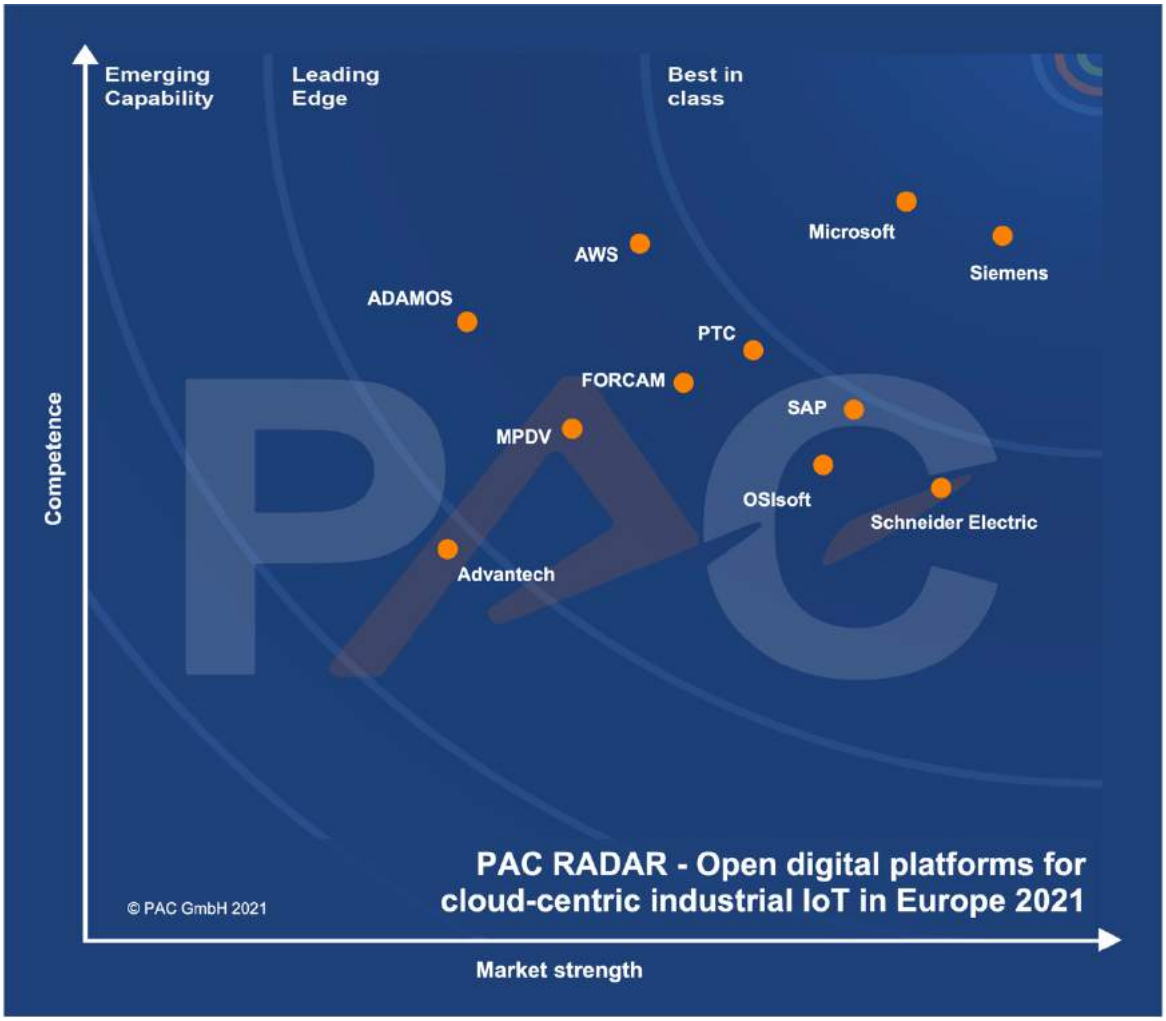

Fig. 3: PAC INNOVATION RADAR Open Digital Platforms for Cloud-centric Industrial IoT in Europe 2021

REVIEW OF TOP-SEEDED PROVIDER SIEMENS

Siemens

PAC INNOVATION RADAR Open Digital Platforms for Cloud-centric Industrial IoT in Europe 2021 — **Best in Class**

Cluster	Average	Siemens
Relative Market Strength	2.26	1.40
Competence	2.21	1.72
Total Score	**2.24**	**1.56**

Criteria rated as significantly ABOVE AVERAGE (more than 0.5)

- Strategic focus on the topic
- Strategic activities in the last 12 months
- Unique selling proposition (USP)
- Platform capabilities
- Complementary services & service quality
- Expansion of go-to-market
- Expansion of use cases & applications
- Market perception
- Ability to grow
- Ecosystem leadership
- Client base and relationships in Europe

Criteria rated as significantly UNDER AVERAGE (more than 0.5)

- None

OBJECTIVE OF THE PAC RADAR

What is the PAC RADAR?

The PAC RADAR is an effective tool for the holistic evaluation and visual positioning of software and ICT service providers on local markets. Numerous ICT and business decision-makers in user companies of all industries and company sizes rely on the PAC RADAR when selecting their partners and developing their sourcing strategies.

With the help of predefined criteria, PAC evaluates and compares providers' strategies, development, and market position in addition to performance and competencies within specific market segments.

Each PAC RADAR focuses on a certain IT market segment. Up to 30 leading providers are evaluated per segment. Participation in the PAC RADAR is free of charge.

All providers are evaluated using PAC's proven methodology, which is based on personal face-to-face interviews and a detailed self-disclosure from each provider.

PAC reserves to also evaluate and position relevant providers in the PAC RADAR that do not participate in the self-disclosure process.

After the evaluation of the predefined criteria, each supplier's position is plotted in the PAC RADAR. The criteria are classified by clusters and can all be attributed to the "Competence" and "Market Strength" main clusters.

The provider evaluation, including a market description, is published as a report.

What is the PAC INNOVATION RADAR?

Concept and methodology of the PAC INNOVATION RADAR are similar to those of the traditional PAC RADAR.

While the traditional PAC RADAR focuses on mature market segments, the PAC INNOVATION RADAR, on the other hand, positions providers in rather new and innovative market segments.

Thus the focus of the evaluation is on the portfolio, vision, strategy, and early client engagements rather than on existing revenue numbers and resources.

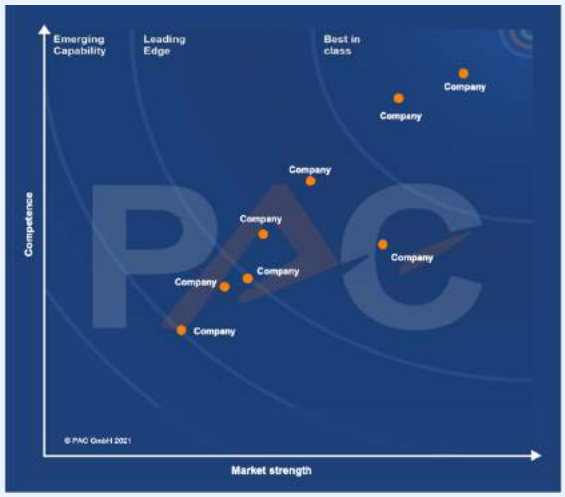

Fig. 4: PAC INNOVATION RADAR graph (exemplary presentation)

SCOPE & DEFINITIONS

What is the basic PAC definition of an open digital platform?

- A **digital platform** provides many digital services based on a joint technical integration layer. The digital platform provides a governance framework which ensures technical interoperability of all independent digital services. This simplifies the use of the different digital services for all users and allows them to add more and more digital services.
- An **open digital platform** extends the above concept by various different aspects:
    - Openness to add **digital services** (applications) from 3rd-party vendors – this creates an open ecosystem.
    - Openness of the **technical integration** layer to integrate different types of hardware and/or software – this is key for industrial IoT.
    - Openness regarding the underlying source code – these platforms are based on **open source**.
    - Openness to **sharing data** with independent parties – but within a controlled environment.
    - Openness of the OT world to leverage **new concepts from the IT world** (such as containers and app stores).

What is the specific PAC definition of the different types of open digital platforms evaluated in this RADAR?

- **Cloud-centric industrial IoT platforms**: On these platforms, application processing happens mainly in the cloud. However, cloud-centric hybrid models with a cloud-controlled extension to the edge are also part of this type of platforms. On these platforms, users can choose from a range of different IoT applications provided by an open ecosystem of partners, often via a cloud-based application marketplace.
- **Edge-centric industrial IoT platforms**: On these platforms (typically based on container technology), application processing happens mainly on or very close to the industrial control system (PLC, industrial PC) in real-time. However, edge-centric hybrid models with an extension to the cloud (private and/or public) are also part of this type of platforms. On these platforms, users can choose from a range of different IoT applications provided by an open ecosystem of partners, often via an app store model (app store runs for example in the cloud, while app processing happens on the industrial controller).
- **Edge cloud-centric industrial IoT platforms:** On these platforms, application processing happens mainly on dedicated infrastructure close to the edge and nearly in real-time. High performance and automation via Kubernetes build the backbone. However, edge cloud-centric hybrid models with an extension to different clouds (private and/or public) are also part of this type of platforms. On these platforms, users can choose from a range of different IoT applications provided by an open ecosystem of partners, preferably via an app store model (app store may run in the cloud, while app processing mainly happens at the edge cloud).
- **Open source-based industrial IoT platforms:** These platforms are based on open source technology and enable large-scale IoT deployments across industrial, mobile and other enterprise-related use cases. The use of open source as a base has three advantages for clients – cost efficiency, vendor independence, and customization capabilities.
- **IoT data exchange & monetization platforms:** These platforms provide a governance framework for secure sharing of IoT-related data between 3rd parties, an app store for IoT data (often including open source data), and additional digital add-on services such as data analytics.
- **Connected worker (AR) platforms:** These platforms are open to many different HW devices (smart glasses) and provide two basic functions to clients, low-code AR application development and AR data visualization.
- **3D printing services platforms:** Digital marketplaces for 3D printing services not only orchestrate the open interaction between different service providers and clients, but increasingly also provide additional digital services to both sides of the market (instant quoting and design optimization services to users, and MES capabilities to providers).

How does PAC segment the provider landscape for open digital platforms?

PAC has evaluated the providers of open digital platforms in Europe in seven PAC INNOVATION RADAR segments dedicated to specific use cases:

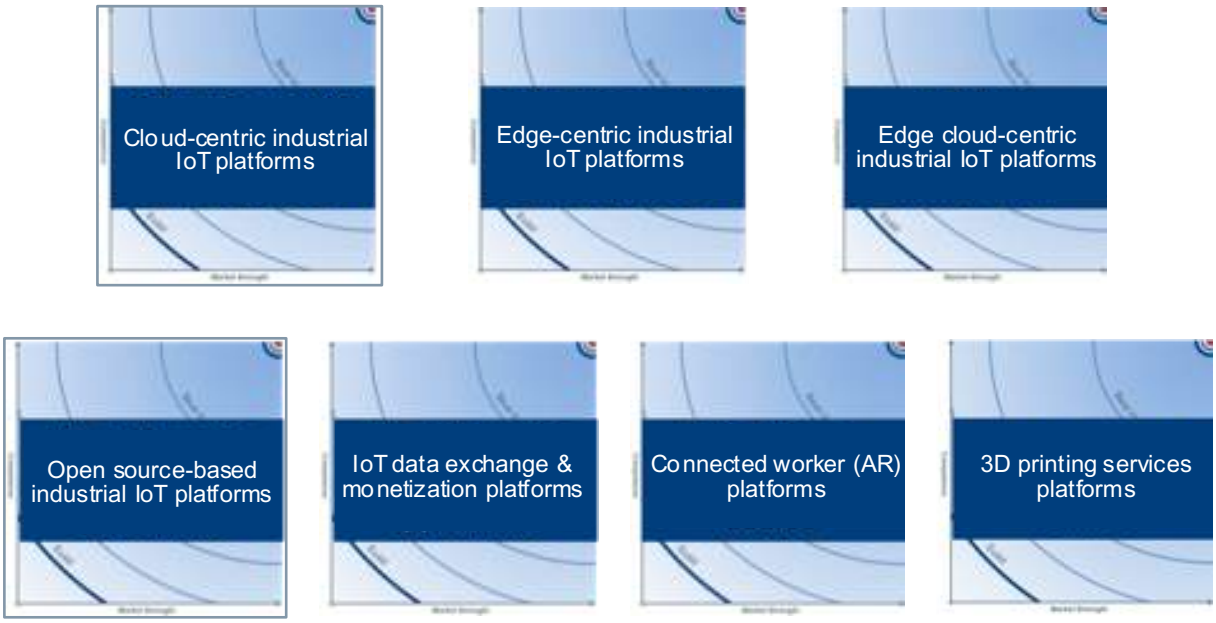

Fig. 5: Overview of the seven PAC INNOVATION RADAR reports on open digital platforms

How will the providers be matched to the different types of open digital platform?

Depending on their specific focus area, the providers will be positioned in one or more of seven PAC INNOVATION RADAR analyses.

PAC RADAR EVALUATION METHOD

Provider selection & participation

Which providers are positioned in the PAC INNOVATION RADAR?

Providers are selected and invited according to the following criteria:

- Size of revenues in the segment to be analyzed in the specified region;
- "Relevance": Even providers that do not belong to the top-selling providers in the segment to be analyzed are considered if PAC classifies them as relevant for potential customers, for instance due to an innovative offering, strong growth, or a compelling vision.

There is no differentiation as to whether the providers are customers of PAC – neither in the selection of the providers to be positioned, nor in the actual evaluation.

What do providers have to do in order to be considered in a PAC INNOVATION RADAR analysis?

The decision as to which providers are considered in the PAC INNOVATION RADAR analysis is entirely up to PAC. Providers do not have any direct influence on this decision.

However, in the run-up to a PAC INNOVATION RADAR analysis, providers can make sure in an indirect way that PAC can adequately evaluate their offerings and positioning – and thus their relevance – e.g. by means of regular analyst briefings, etc.

Why should providers accept the invitation to actively participate?

Whether or not a provider participates in the RADAR process does not actually affect their inclusion and positioning in the PAC INNOVATION RADAR, nor their assessment. However, there are a whole host of benefits associated with active participation:

- Participation ensures that PAC has access to the largest possible range of specific and up-to-date data as a basis for the assessment;
- Participating providers can set out their specific competencies, strengths, and weaknesses as well as their strategies and visions;
- The review process guarantees the accuracy of the assessed factors;
- The provider gets a neutral, comprehensive, and detailed view of their strengths and weaknesses as compared to the direct competition – related to a specific service in a local market;
- A positioning in the PAC INNOVATION RADAR gives the provider prominence amongst a broad readership as one of the leading operators in the segment under consideration

Considered providers by segment

Open Digital Platforms for Cloud-centric Industrial IoT	Open Digital Platforms for Edge-centric Industrial IoT	Open Digital Platforms for Edge Cloud-centric Industrial IoT	Open Digital Platforms for Open Source-based Industrial IoT
• ADAMOS • Advantech • Amazon Web Services (AWS) • FORCAM • Microsoft • MPDV • OSIsoft • PTC • SAP • Schneider Electric • Siemens	• Beckhoff Automation • Bosch Rexroth • B&R Industrial Automation • Controllino • KUNBUS • Litmus Automation • Mitsubishi Electric • Phoenix Contact • Rockwell Automation • Schneider Electric • Siemens • WAGO	• Canonical • Edgeworx • German Edge Cloud • IBM/ Red Hat • IOTech • IoTium • Mirantis • SUSE Rancher • VMware • Wind River	• Bosch.IO • DeviceHive • Dianomic • EMQ • Eurotech • Kaa • Mainflux • MathWorks • SiteWhere • Thinger.io • ThingsBoard

Open Digital Platforms for IoT Data Exchange & Monetization	Open Digital Platforms for Connected Workers (AR)	Open Digital Platforms for 3D Printing Services
• Amazon Web Services (AWS) • Caruso • Databroker • Deutsche Telekom/ T-Systems • Google • MathWorks • Otonomo • Snowflake • Terbine • Wejo	• Amazon Web Services (AWS) • Apple • Atheer • DIOTA • Google • Microsoft • oculavis • PTC • RE'FLEKT • Scope AR • TeamViewer (Ubimax) • Upskill	• 3D Hubs • Dassault Systèmes • FACTUREE • Fictiv • Jellypipe • makexyz • PROTIQ • Xometry

The concept

Fig. 6: PAC INNOVATION RADAR – evaluation method

PAC uses **predefined criteria** to assess and compare the providers within given service segments.

The assessment is based on the report-card score within the peer group of the positioned providers.

This is based on:

- The provider's detailed self-disclosure about resources, distribution, delivery, portfolio, contract drafting, pricing, customer structure, customer references, investments, partnerships, certifications, etc.;
- If applicable, a poll among customers by PAC;
- The analysis of existing PAC databases;
- Secondary research;
- Dedicated face-to-face interviews as relevant.

The provider data is verified by PAC and any omissions are rectified based on estimates.

If the provider does not participate, the assessment is performed using the proven PAC methodology, in particular based on:

- Information obtained from face-to-face interviews with the provider's representatives, analyst briefings, etc.;
- An assessment of company presentations, company reports, etc.;
- An assessment of PAC databases;
- An assessment of earlier PAC (INNOVATION) RADARs in which the provider participated;
- A poll among the provider's customers (as required) on their experiences and satisfaction.

Reissue of published RADARs

The assessments in the PAC INNOVATION RADAR represent an assessment of the providers within the given peer group in the year in which the respective PAC INNOVATION RADAR was published.

The evaluations may not be directly comparable with those of any previous version due to subsequent content modifications. In particular, they do not depict a development of individual providers over time.

Methodological and/or organizational modifications may be made due to changing market conditions and trends and may include:

- Different peer group in the focus of the analysis;
- Modification of individual criteria within clusters and sub-clusters;
- Increased or altered expectations by user companies;
- Adjustment of the weighting of individual criteria.

Evaluation criteria

Open Digital Platforms for Cloud-centric Industrial IoT	Open Digital Platforms for Edge-centric Industrial IoT

Main cluster "Competence"
• **Sub-cluster "Strategy"**
  ○ Strategic focus on the topic
  ○ Strategic activities over the last 12 months
  ○ Unique selling proposition (USP)
• **Sub-cluster "Portfolio"**
  ○ Open app store
  ○ Platform capabilities
  ○ Complementary services & service quality
• **Sub-cluster "Expansion"**
  ○ Expansion of go-to-market
  ○ Expansion to new use cases & applications
  ○ Expansion to new technology
	Main cluster "Competence"
	• **Sub-cluster "Strategy"**
	  ○ Strategic focus on the topic
	  ○ Strategic activities over the last 12 months
	  ○ Unique selling proposition (USP)
	• **Sub-cluster "Portfolio"**
	  ○ Application development & open app store
	  ○ Platform capabilities
	  ○ Complementary services & service quality
	• **Sub-cluster "Expansion"**
	  ○ Expansion of go-to-market
	  ○ Expansion to new use cases & applications
	  ○ Expansion to new technology

Main cluster "Market Strength"
• **Sub-cluster "Market Growth"**
  ○ Market perception in Europe
  ○ Awareness
  ○ Image
  ○ Ability to grow
  ○ Agility
  ○ Momentum
• **Sub-cluster "Market Position"**
  ○ Ecosystem leadership
  ○ Size and quality of partner ecosystem
  ○ Activities in relevant communities
  ○ Client base and relationships in Europe
  ○ Client base in Europe
  ○ Client relationships in Europe
	Main cluster "Market Strength"
	• **Sub-cluster "Market Growth"**
	  ○ Market perception in Europe
	  ○ Awareness
	  ○ Image
	  ○ Ability to grow
	  ○ Agility
	  ○ Momentum
	• **Sub-cluster "Market Position"**
	  ○ Ecosystem leadership
	  ○ Size and quality of partner ecosystem
	  ○ Activities in relevant communities
	  ○ Client base and relationships in Europe
	  ○ Client base in Europe
	  ○ Client relationships in Europe

Open Digital Platforms for Edge Cloud-centric Industrial IoT	Open Digital Platforms for Open Source-based Industrial IoT

Main cluster "Competence"
• **Sub-cluster "Strategy"**
  ○ Strategic focus on the topic
  ○ Strategic activities over the last 12 months
  ○ Unique selling proposition (USP)
• **Sub-cluster "Portfolio"**
  ○ Industrial IoT capabilities
  ○ Platform capabilities
  ○ Complementary services & service quality
• **Sub-cluster "Expansion"**
  ○ Expansion of go-to-market
  ○ Expansion to new use cases & applications
  ○ Expansion to new technology
 	
Main cluster "Market Strength"
• **Sub-cluster "Market Growth"**
  ○ Market perception in Europe
  ○ Awareness
  ○ Image
  ○ Ability to grow
  ○ Agility
  ○ Momentum
• **Sub-cluster "Market Position"**
  ○ Ecosystem leadership
  ○ Size and quality of partner ecosystem
  ○ Activities in relevant communities
  ○ Client base and relationships in Europe
  ○ Client base in Europe
  ○ Client relationships in Europe
	Main cluster "Competence"
	• **Sub-cluster "Strategy"**
	  ○ Strategic focus on the topic
	  ○ Strategic activities over the last 12 months
	  ○ Unique selling proposition (USP)
	• **Sub-cluster "Portfolio"**
	  ○ Open source-based capabilities at the edge
	  ○ Open source-based capabilities of the IoT platform
	  ○ Complementary services & service quality
	• **Sub-cluster "Expansion"**
	  ○ Expansion of go-to-market
	  ○ Expansion to new use cases
	  ○ Expansion to new technology
	
	Main cluster "Market Strength"
	• **Sub-cluster "Market Growth"**
	  ○ Market perception in Europe
	  ○ Awareness
	  ○ Image
	  ○ Ability to grow
	  ○ Agility
	  ○ Momentum
	• **Sub-cluster "Market Position"**
	  ○ Ecosystem leadership
	  ○ Size and quality of partner ecosystem
	  ○ Activities in relevant communities
	  ○ Client base and relationships in Europe
	  ○ Client base in Europe
	  ○ Client relationships in Europe

Open Digital Platforms for IoT Data Exchange & Monetization	Open Digital Platforms for Connected Workers (AR)

Main cluster "Competence"
• **Sub-cluster "Strategy"**
  ○ Strategic focus on the topic
  ○ Strategic activities over the last 12 months
  ○ Unique selling proposition (USP)
• **Sub-cluster "Portfolio"**
  ○ Total number of data sources
  ○ Value of data sources
  ○ Complementary services & addressed use cases
• **Sub-cluster "Expansion"**
  ○ Expansion of go-to-market
  ○ Expansion to new use cases & data
  ○ Expansion to new partners
 	
Main cluster "Market Strength"
• **Sub-cluster "Market Growth"**
  ○ Market perception in Europe
  ○ Awareness
  ○ Image
  ○ Ability to grow
  ○ Agility
  ○ Momentum
• **Sub-cluster "Market Position"**
  ○ Ecosystem leadership
  ○ Size and quality of partner ecosystem
  ○ Activities in relevant communities
  ○ Client base and relationships in Europe
  ○ Client base in Europe
  ○ Client relationships in Europe
	Main cluster "Competence"
	• **Sub-cluster "Strategy"**
	  ○ Strategic focus on the topic
	  ○ Strategic activities over the last 12 months
	  ○ Unique selling proposition (USP)
	• **Sub-cluster "Portfolio"**
	  ○ Addressed industrial use cases
	  ○ Portfolio quality based on client references
	  ○ HW- & SW-related interoperability
	• **Sub-cluster "Expansion"**
	  ○ Expansion of go-to-market
	  ○ Expansion to new use cases
	  ○ Expansion to new technology
	
	Main cluster "Market Strength"
	• **Sub-cluster "Market Growth"**
	  ○ Market perception in Europe
	  ○ Awareness
	  ○ Image
	  ○ Ability to grow
	  ○ Agility
	  ○ Momentum
	• **Sub-cluster "Market Position"**
	  ○ Ecosystem leadership
	  ○ Size and quality of partner ecosystem
	  ○ Activities in relevant communities
	  ○ Client base and relationships in Europe
	  ○ Client base in Europe
	  ○ Client relationships in Europe

Open Digital Platforms for 3D Printing Services

Main cluster "Competence"

- **Sub-cluster "Strategy"**
  - Strategic focus on the topic
  - Strategic activities over the last 12 months
  - Unique selling proposition (USP)
- **Sub-cluster "Portfolio"**
  - Addressed industrial use cases
  - Services for buyers
  - Services for suppliers
- **Sub-cluster "Expansion"**
  - Expansion of go-to-market
  - Expansion of services for buyers
  - Expansion of services for suppliers

Main cluster "Market Strength"

- **Sub-cluster "Market Growth"**
  - Market perception in Europe
    - Awareness
    - Image
  - Ability to grow
    - Agility
    - Momentum
- **Sub-cluster "Market Position"**
  - Ecosystem leadership
    - Size and quality of partner ecosystem
    - Activities in relevant communities
  - Client base and relationships in Europe
    - Client base in Europe
    - Client relationships in Europe

General PAC research method

The following overview describes PAC's research method for market analysis and key differentiation features.

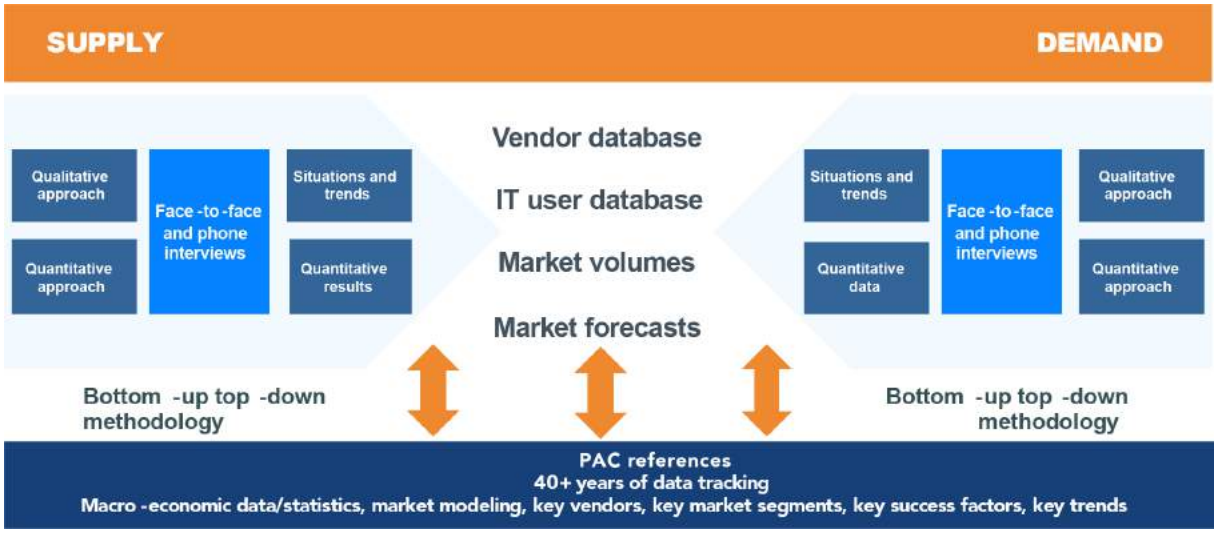

Fig. 7: Description of the PAC methodology

Local research and face-to-face communication are two core elements of PAC's methodology. In our market studies, we can draw on more than 40 years of experience in Europe.

Positioning within the PAC INNOVATION RADAR

Based on the scores in competence and market strength, the overall score is calculated (calculation: competence score plus market strength score, divided by two). From the resulting overall score, each provider receives their characteristic positioning within the PAC INNOVATION RADAR. Here, the following applies: The closer a provider is to the upper right corner, the closer they are to meeting customers' requirements for that segment.

The classification of providers is based on the overall score:

“Best in Class”	1.0 – 1.9
“Leading Edge”	2.0 – 2.9
“Emerging Capability”	3.0 – 3.9
“Solid”	4.0 – 4.9

Fig. 8: Classification of providers in the PAC INNOVATION RADAR graph (example)

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