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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 Open Source-based Industrial IoT

– Positioning of Eurotech and Bosch.IO (Eclipse Foundation) –

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PAC, July 2021

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Publication: July 2021

Scope ID: Digital Innovation & IoT I Europe I 2021
Portfolio ID: SITSI I Vendor Analysis I PAC RADAR
Related reports: This document is part of a series of seven PAC RADAR reports.

PAC INNOVATION RADAR GRAPH

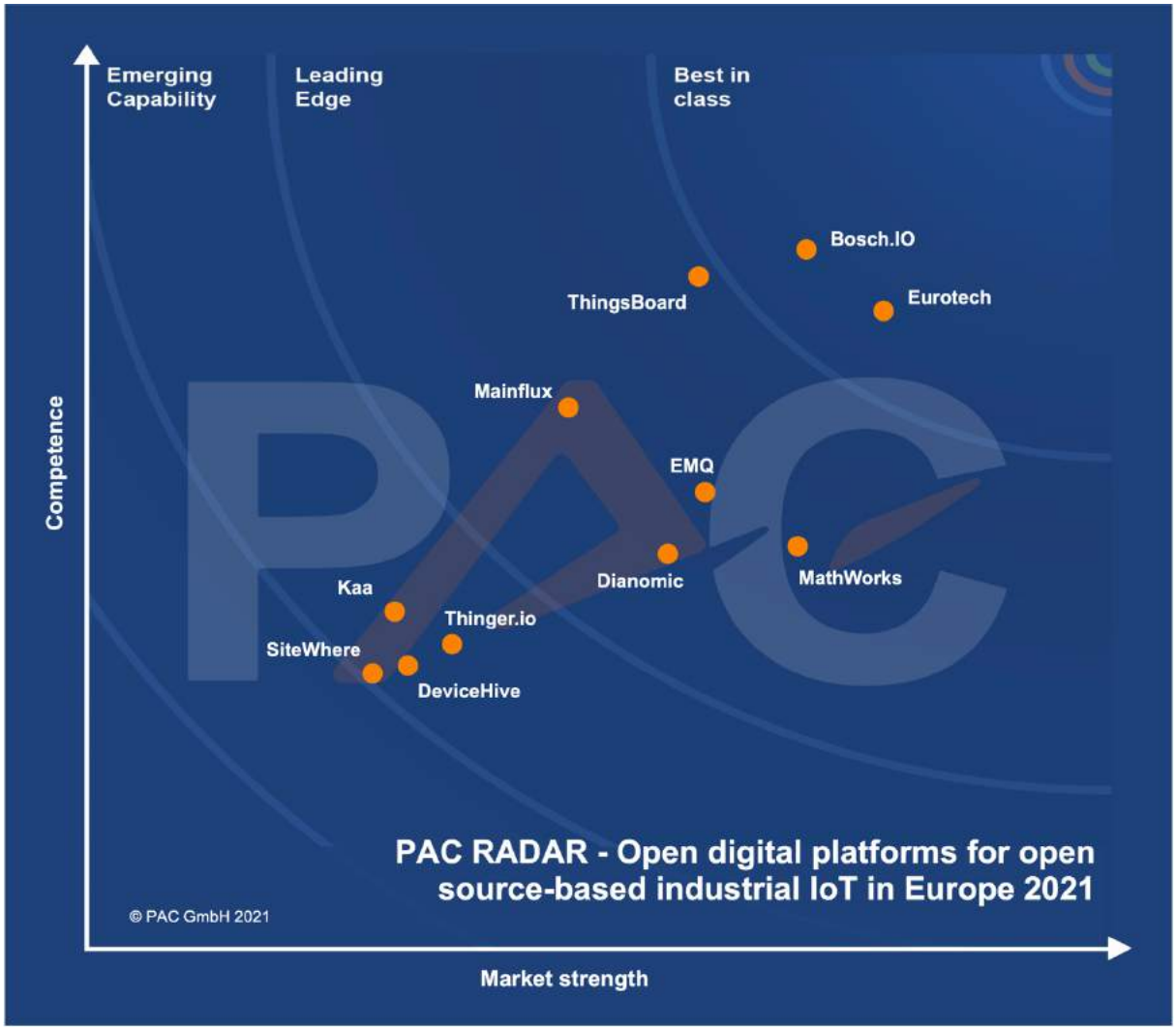


Fig. 1: PAC INNOVATION RADAR graph

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

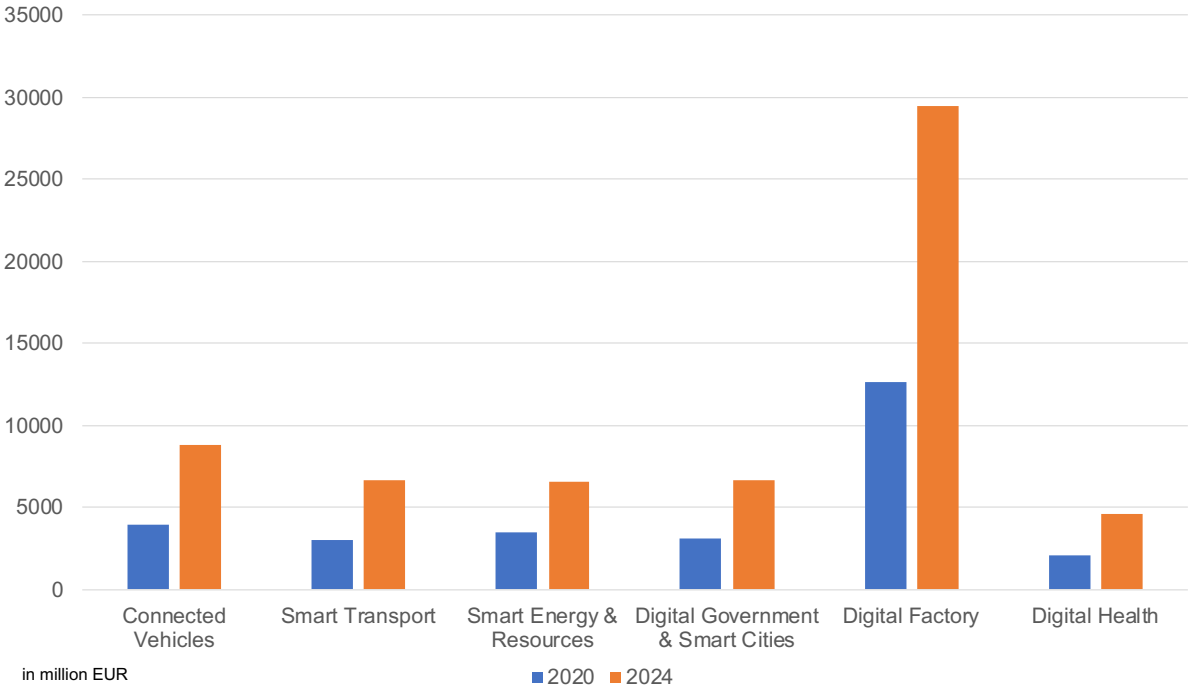


Fig. 2: IoT market size by IoT contexts in Western Europe, 2020 & 2024

MARKET SITUATION

Open source-based industrial IoT platforms have a strong focus on leveraging open source technologies for large-scale IoT deployments across industrial, mobile, and other enterprise-related use cases. As the market for IoT platforms is maturing, we observe that open source-based industrial IoT platforms are becoming a real alternative for many users in the market. There are four main reasons for this.

First, open source software in general is already very popular among user companies in many areas of the IT world. The most prominent example is certainly Linux in the operating systems space. Another very important topic in the open source context has emerged over the past few years – Kubernetes for container orchestration. Second, we expect the attractiveness of open source for user companies to keep growing. Avoiding vendor lock-in is high on the agenda of European companies. Independence from market-dominating vendors that might become a competitive threat to manufacturing companies on their home turf is a key issue. Third, clients with their own developer resources and/or a strong need to adapt an IoT platform to their specific needs like open source. This is often driven by highly specific requirements of niche markets and/or individual security and compliance requirements. Fourth, clients with more general, basic needs around IoT data acquisition and visualization are also looking for open source-based solutions to limit costs. While in this market evaluation, we mainly focus on the more complex side of the market, it is worth mentioning that more basic IoT platform services are also becoming more popular for simple use cases.

Market trends & insights

We basically observe two different forms of IoT-related open source communities. On the one hand, there are developer communities which are dominated by one single vendor and interact via platforms such as GitHub (e.g. DeviceHive, DGLogik, Kaa, Mainflux, SiteWhere, Thinger.io, and ThingsBoard). On the other hand, there are open source communities that follow the strict guidelines and governance frameworks of open source foundations such as Linux, Apache, and Eclipse. These foundations ensure that no single entity can control the strategy, policies, and operation of projects. PAC prefers the open source model led by foundations. This gives user companies more transparency and participation options, and therefore generates more trust in future advancement.

We saw the establishment of two IoT-related communities under the umbrella of the Linux Foundation in 2019. However, we have seen no progress of their projects so far. Our impression is that the two Linux communities, the IoT Edge Working Group and LF Edge (incl. EdgeX Foundry), have not been working together in an efficient way so far.

From our perspective, the Eclipse Foundation, with the Eclipse IoT Working Group, is without doubt the leading open source community around IoT today. While

the Eclipse project started around 20 years ago, the IoT Working Group can look back on as many as 10 years of progress. No other community drives more open source-based IoT projects (a portfolio of 45+ projects) simultaneously. It is no surprise that the two vendors that were positioned as Best in Class in this PAC RADAR – Eurotech and Bosch.IO – are part of this community. Equally remarkable is the fact that the Eclipse Foundation recently moved its headquarters from the US to Brussels, Belgium (as an AISBL non-profit association). This reflects a strong commitment to the European market and the associated values, such as Europe's strong privacy and security standards.

We can make out two factors indicating that the market for open source-based industrial IoT platforms is entering a more mature stage. First, the vendor landscape has been showing only limited change. We just added Dianomic as a new vendor to this PAC RADAR. Second, there is already a clear gap between the leading vendors (Bosch.IO, Eurotech, and ThingsBoard) and the rest of the market.

We observe strong efforts by the leading vendors to enhance their edge capabilities. This underscores the fact that the future is hybrid, and more complex industrial IoT use cases typically require strong capabilities in both areas, edge and cloud.

Important capabilities of leading platforms

What makes an open source-based industrial IoT platform attractive to users? As pointed out above, the use of open source as a base offers three major benefits for clients – cost-efficiency, vendor independence, enterprise-grade services, and customization capabilities. To support their clients in the best possible way, leading platforms require the following capabilities: first, ensuring long-term software support for clients. This can be done through individual software support services, but it is even better for a client to be able to rely on a strong community of companies and developers to ensure long-term software support. We consider a constant stream of platform enhancements as highly relevant. The faster this stream, the better for users. This includes bug fixes for existing code, but also the development of totally new components to enhance current functionality. This basically means for users that large and highly dedicated developer communities can provide the best value in the long run. This underlines the relevance of agile open source communities. In our view, they can ensure more trust in long-term software support and vendor independence. Second, software development and system integration capabilities are big assets in client-specific customization projects. These capabilities should be proven through client references. Third, IoT platform capabilities in the cloud are usually sufficient for many simple IoT use cases, but additional capabilities at the edge are very important for many more complex, industrial IoT use cases. Fourth, vendors need an attractive

business model that supports clients' focus on a cost-effective IoT solution. Vendors can earn money in the open source context from surrounding software, hardware, and services. In terms of services, this includes various areas, such as consulting and systems integration, hosting, and software support services. When it comes to hardware, this mainly means IoT gateways. In terms of software, this refers to proprietary software components for specific add-on functions, such as a freemium business model where the vendor gives a large part of the software code away for free (otherwise the attractiveness for users would be very limited and nobody would use the IoT platform) and just monetizes some value-adding capabilities (e.g. around large-scale deployments).

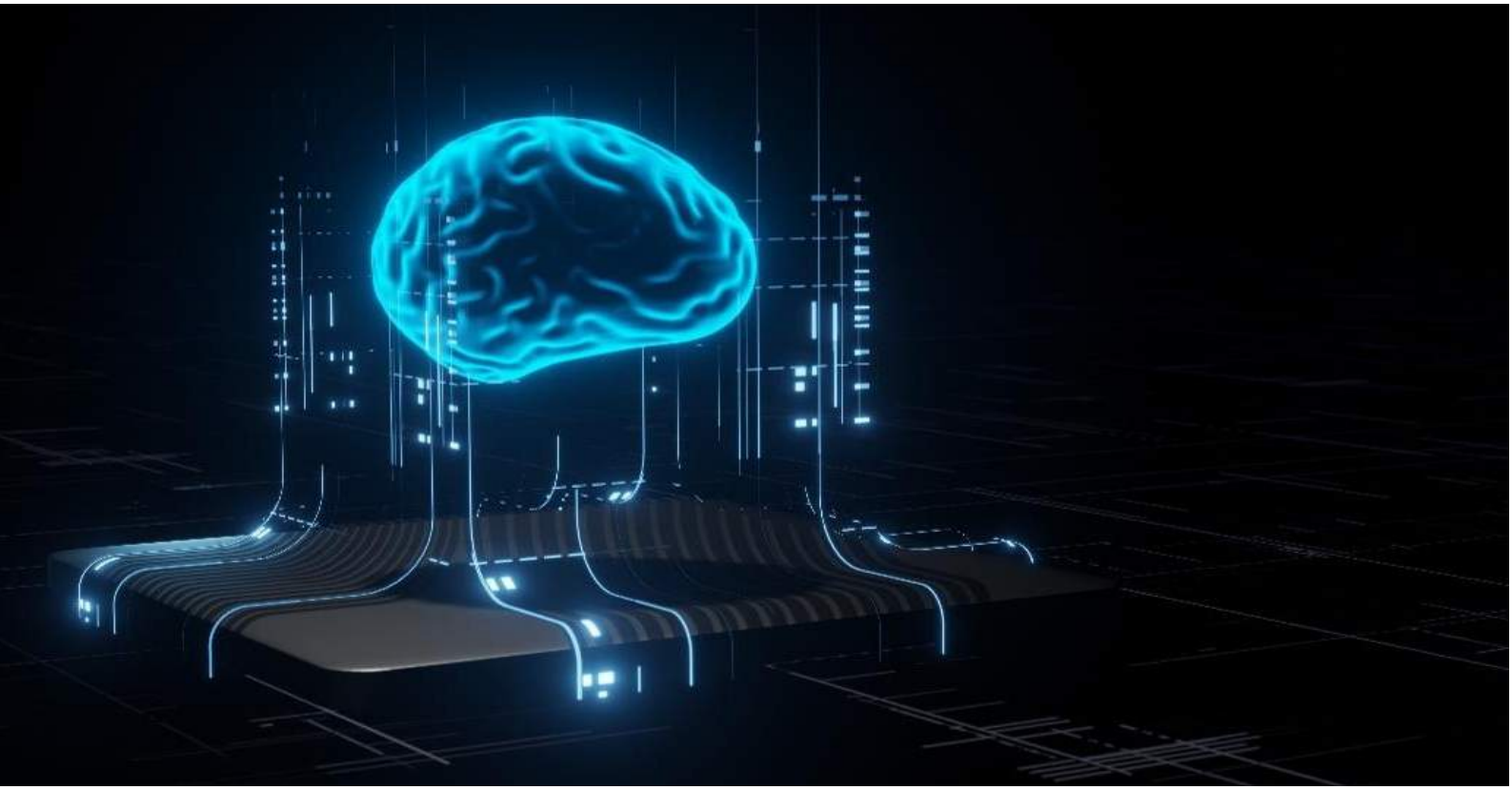
Leading vendors

In our view, Bosch.IO (previously Bosch Software Innovations) is still a leader in this market segment. Today, it manages more than 15 million IoT devices (including sensors and machines) via its open source-based IoT platform. The core of the Bosch IoT Suite is built on top of Eclipse IoT open source projects. For example, Bosch IoT Hub is a commercial product based on Eclipse Hono; Bosch IoT Rollouts is a commercial product based on Eclipse hawkBit; Bosch IoT Things is a commercial product based on Eclipse Ditto. Generally speaking, Bosch is a main contributor to the Eclipse IoT Working Group (since 2015, Bosch has been one of three strategic members of this community, together with Eurotech and Red Hat). In addition to its strong contribution to the overall evolution of open source IoT and edge, Bosch.IO offers its clients a strong and broad portfolio of services and support dedicated to open source IoT. A team of 900 AIoT (AI & IoT) experts supports clients around all aspects of open source-based industrial IoT. This includes consulting, customized software development, solution architecture, change management, user experience design, business model innovation, and training. The quality of these services is confirmed by relevant client references.

Eurotech is uniquely positioned in the market, able to offer IoT and edge computing building blocks, from very compact High Performance Embedded Computers (HPECs) to edge servers and IoT gateways, in combination with an integrated IoT software framework for edge and distributed computing, fully based on open source. The company's unique positioning is the basis for open collaboration with many big IT companies. The most recent examples are cooperations with Infineon, GlobalSign, and Microsoft around IoT security (chain of trust), with NVIDIA around edge AI (NVIDIA GPUs in Eurotech edge hardware), with AWS around IoT edge to cloud (qualification of Everyware Software Framework with AWS IoT Core). Eurotech has also extended its partnerships with system integrators such as IBM and DXC Technology. In addition, Eurotech was one of the founding members of the IoT Working Group within the Eclipse Foundation back in 2012. Before that, Eurotech had been co-developing MQTT (a lightweight IoT messaging protocol) with and for IBM, which led to one of the initial contributions to Eclipse IoT, the Paho project by Eurotech and IBM (another founding member of the IoT Working Group at Eclipse). The code of the Eclipse Paho project provides a very popular open source client implementation of the MQTT messaging protocol. On top of this, Eurotech also contributed the Kura project (today available as version 5.0) to the Eclipse Foundation and is one of the driving forces (with contributions from Red Hat) behind the Kapua project (today available as version 1.5). Kura is an IoT edge middleware for IoT gateways, edge servers, and other smart field assets. It provides full device abstraction, device and software life cycle management, IoT cloud platform connectors, support for field protocols, and Kura Wires for no-code programming. The Kapua project provides

open source, enterprise-grade IoT platform capabilities at the back end (cloud and on-premises), including the management of devices and data. Both Eclipse projects, Kura and Kapua, are the basis for commercially supported offerings from Eurotech, branded Everyware Software Framework and Everyware Cloud, which add features such as advanced logging, X.509 certificate-based security, and additional field protocols. The combination of Eurotech's strong commitment to open source-based IoT solutions and open collaboration, and its strong capabilities in IoT hardware and embedded solutions makes the company a strong IoT ecosystem player. This is reflected by the many reference clients they have across Europe in industries as varied as industrial automation, transportation, agriculture, and energy & utilities.

The strengths of ThingsBoard can be split into two categories – fast development cycles and a fast-growing community on GitHub. While ThingsBoard has been moving forward with many small release updates (in March 2021, ThingsBoard 3.3.2 was released), we simultaneously observe a fast-growing community on GitHub. This is underscored by more than 8,500 GitHub stars (up from around 6,000 GitHub stars in 2020). ThingsBoard clearly focuses on more basic IoT use cases such as data visualization and monitoring, and it can point to working with several European enterprise clients in this space, such as Deutsche Telekom, Bosch, and Engie.



PAC INNOVATION RADAR “OPEN DIGITAL PLATFORMS FOR OPEN SOURCE-BASED INDUSTRIAL IOT IN EUROPE 2021”

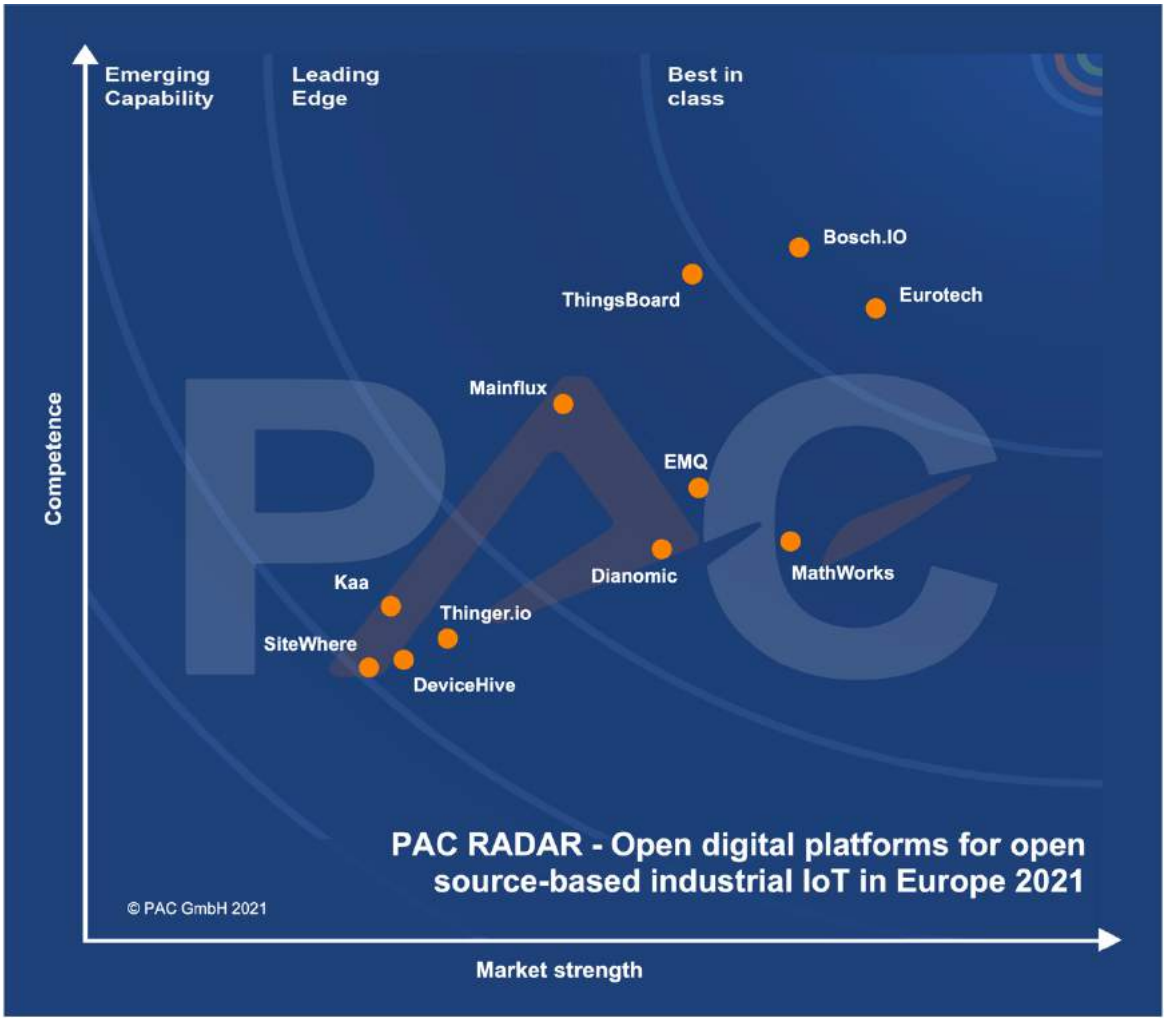


Fig. 3: PAC INNOVATION RADAR Open Digital Platforms for Open Source-based Industrial IoT in Europe 2021

REVIEW OF TOP-SEEDED PROVIDERS EUROTECH AND BOSCH.IO

Eurotech

PAC INNOVATION RADAR Open Digital Platforms for Open Source-based Industrial IoT in Europe 2021 **Best in Class**

Cluster	Average	Eurotech
Relative Market Strength	2.79	1.78
Competence	2.75	1.97
Total Score	**2.77**	**1.88**

Criteria rated as significantly ABOVE AVERAGE (more than 0.5)

- Strategic focus on this topic
- Strategic activities in the last 12 months
- Unique selling proposition (USP)
- Open source-based capabilities at the edge
- Complementary services & service quality
- Expansion of go-to-market
- Expansion to new technology
- Market perception
- Ability to grow
- Ecosystem leadership
- Client base and relationships in Europe

Criteria rated as significantly UNDER AVERAGE (more than 0.5)

- None

Bosch.IO

PAC INNOVATION RADAR Open Digital Platforms for Open Source-based Industrial IoT in Europe 2021 **Best in Class**

Cluster	Average	Bosch.IO
Relative Market Strength	2.79	2.03
Competence	2.75	1.76
Total Score	**2.77**	**1.90**

Criteria rated as significantly ABOVE AVERAGE (more than 0.5)

- Strategic focus on this topic
- Strategic activities in the last 12 months
- Unique selling proposition (USP)
- Open source-based capabilities of the IoT platform
- Complementary services & service quality
- Expansion of go-to-market
- Expansion to new use cases
- Expansion to new technology
- Market perception
- 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.

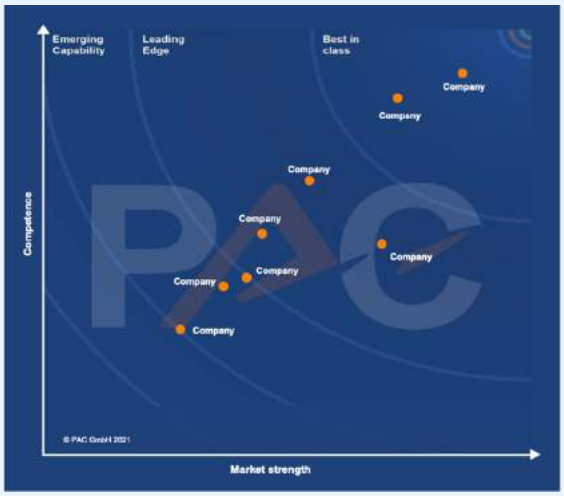


Fig. 4: PAC INNOVATION RADAR graph (exemplary presentation)

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.

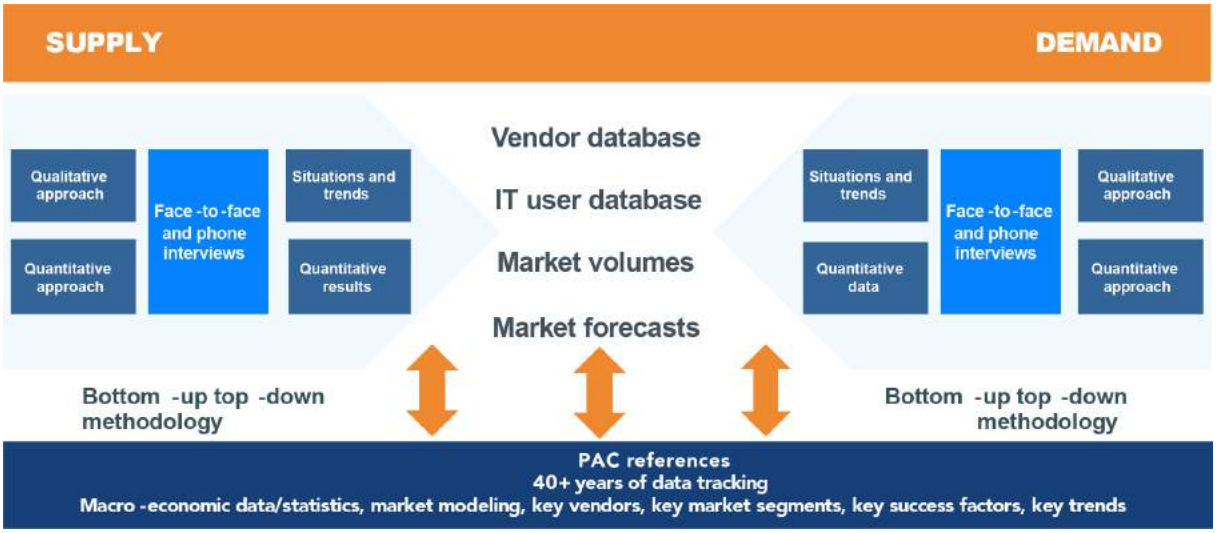


Fig. 7: Description of the PAC methodology

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

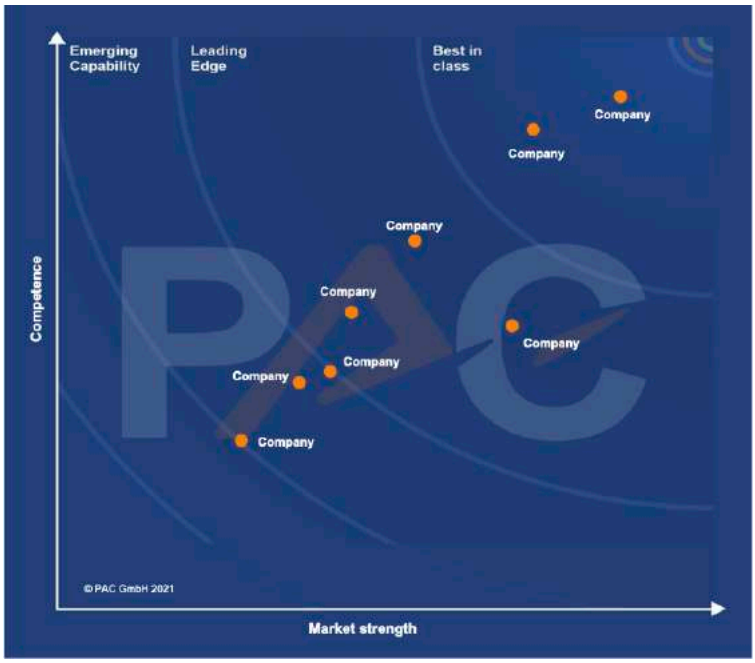


Fig. 8: Classification of providers in the PAC INNOVATION RADAR graph (example)

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