



# Aspen PIMS-AO Deployment in the Cloud

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# Introduction

In the current fourth industrial revolution, digital technology is a major competitive advantage. Digital technology, such as cloud computing, the industrial internet of things (IIoT) and artificial intelligence (AI), has the potential to completely transform business models and vastly increase margins in the energy and chemicals sectors of the global economy. For example, the World Economic Forum in collaboration with McKinsey & Company projected a significant difference between companies that proactively adopt AI within the first 7 years and those that lag behind: AI adoption vanguards can expect a cumulative 122% cash-flow change, while laggards will see only a 10% cash-flow change.<sup>i</sup> Adopting cloud computing can deliver smaller benefits, but at much less effort. The same study stated that cloud systems offer benefits in speed, agility and incremental cost advantages, all for nominal investment. In addition, cloud solutions work well without costly installation.

Cloud technology emerged in the late 1990s and early 2000s. Cloud became a buzzword in 2010-2011, and after a few years of skepticism, cloud solutions spread like wildfire. They have now become ubiquitous. Today, the world's most successful businesses and millions of consumers trust Microsoft Office 365, Salesforce.com, MATLAB and countless other cloud services with sensitive, secure data and processes. The successful deployment of these solutions has opened the door for even more cloud applications.

With the advent of new digital technology, many organizations are actively pursuing a digitalization strategy. Digitalization means turning interactions, communications, business functions and business models into (more) digital ones which often boils down to a mix of digital and physical as in omnichannel customer service, integrated marketing or smart manufacturing with a mix of autonomous, semi-autonomous and manual operations.<sup>ii</sup> Cloud computing is a landmark solution for all these objectives.





## What is The Cloud

Microsoft describes the cloud as “the delivery of computing services—servers, storage, databases, networking, software, analytics, intelligence and more—over the Internet.”<sup>iii</sup> Simply put, the cloud is the internet. Cloud services are attractive because they offer faster innovation in the form of continuously upgraded hardware, flexible resources that are only used and paid for when needed and economies of scale where you can solve many problems with the same servers.

Turning the discussion to production planning in refining and bulk chemicals, cloud computing can be used for speed to solve a large case set very quickly.

One common misconception about cloud is that it is less secure than on-premises (“on-prem”) computers. In reality, however, physical attacks, email attacks and network attacks are extremely common, whether your computing infrastructure is on-premises or off. To improve security, one could use a private cloud which is more secure than a public cloud. In AspenTech’s experience thus far, our customers have opted for private clouds every time.

### Public cloud

Data is stored in a provider’s data center: the provider is responsible for managing and maintaining the data center. Though one cloud provider may host data for multiple customers, each company’s data is kept separate. This type of cloud environment appeals to many companies because it reduces lead times in testing and deploying new products. However, many companies believe a public cloud is less secure. Though you don’t control the security of a public cloud, security breaches are rare.

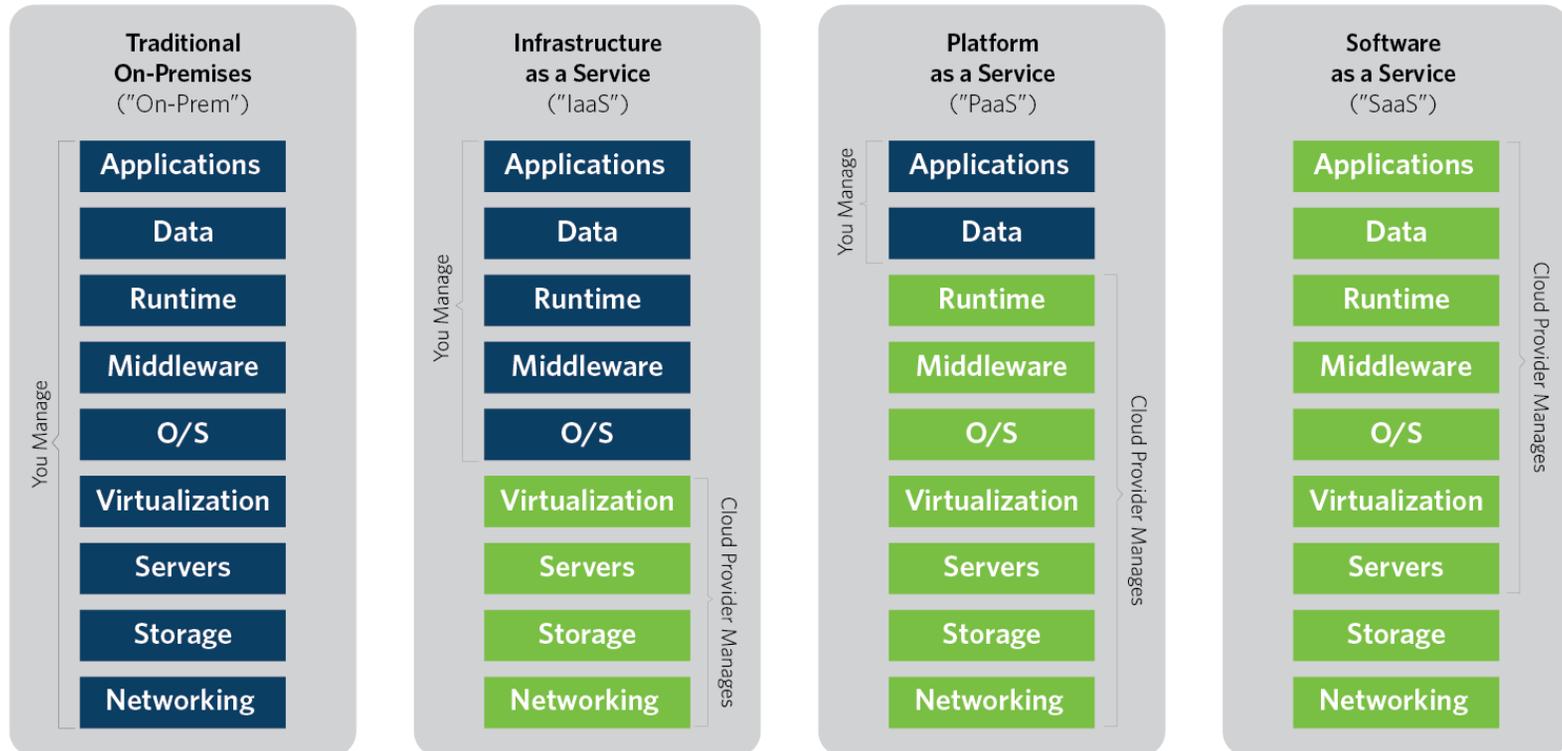
### Private cloud

Data resides on your company’s intranet or hosted data center, protected behind a firewall. This storage is dedicated to your company only, connected via a private network. It may also be on-premises, although not required. This private network improves security while increasing costs. Sometimes this can be called a cluster of computers.



Additionally, there is also the concept of software as a service or SaaS, which many people equate with the cloud. However, they are different. The primary difference: SaaS offers fully formed end-user applications (i.e. Salesforce.com or Facebook), whereas cloud computing is simply computing infrastructure—such as servers, processors, and storage—that you can rent as you need it. SaaS offerings are applications in themselves, housed in the cloud, typically accessed through a browser. Many owner-operators have concerns about SaaS because of the sensitivity of the intellectual property in their planning models, such as pricing forecasts or reactor yields. To be clear, the scope of this paper is just cloud, not SaaS.

To summarize the differences, let us review this diagram based on one developed by Microsoft. The traditional on-prem structure is shown on the left; cloud computing includes the middle two sections, Infrastructure as a Service and Platform as a Service. SaaS is at the far right.



Cloud computing typically improves processing speed by one to two orders of magnitude – 10 to 100 times faster than multi-core processing on a single machine. Cloud computing often also reduces total cost of ownership (TCO), especially for processing-intensive applications like Aspen PIMS-AO™. Understanding how cloud computing works and the business case for cloud – especially in the context of planning using PIMS-AO – is imperative for you to derive value from this technology. In addition, examining the specific benefits and examples of cloud deployment for the Aspen PIMS™ Family may guide your decision whether to move to the cloud.

## The Business Case for Action

Global markets for crude, refined products, chemicals feedstocks and chemicals products are volatile and complex. This environment increases the risk of losses when doing business. AspenTech helps our customers mitigate this risk by empowering them to better predict the future. Considering more possible outcomes arms businesses with the insight they need to make the best choices — in the planning community, we often call this *scenario analysis*. In consulting clients around the world, AspenTech’s planning experts consistently observe interest in analyzing more scenarios. Customers want to evaluate hundreds, if not thousands of cases.

**“We could create a strong plan, but we were not prepared for the changes. To remedy this, we needed more mapping to understand the uncertain business scenarios. When we first made the required case set, it took two days to run. This was unacceptable. Our time to market needed to be faster. With Aspen PIMS-AO, it was.”**

**Daniel Cseh, Engineer, Manage Uncertainty Project, MOL Group**



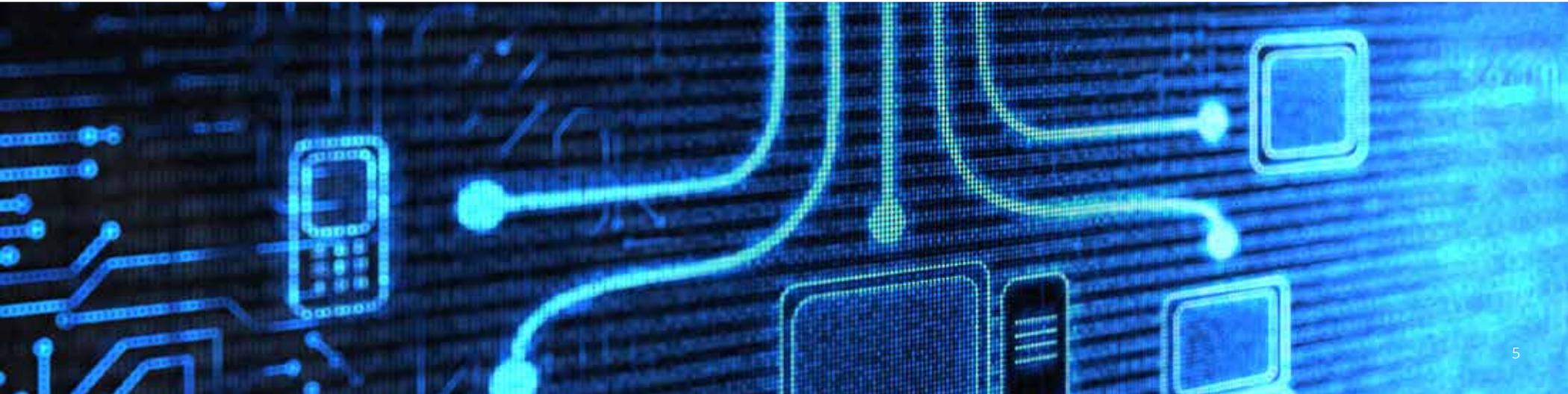
For example, at AspenTech's OPTIMIZE 2019 conference, Daniel Cseh, Optimization Expert from MOL Group, showed how they increased the average number of scenarios analyzed from about 30 in early 2017 to over 300 in early 2019. The scenarios checked include varying prices, unit rates (CAPS), process limits (PROCLIMs), starting inventories and more. Based on operating experience, they identified the most important pulse points of their operations and tested what would happen if those were different than expected. This allowed them to map a preemptive response plan to operational upsets, enabling agility and faster optimal decision-making. PIMS-AO's parallel processing capability allowed the MOL team to examine more than 300 cases.

Over the last 5 years, planners and economists have increased production planning efficiency by solving cases 5 or 10 times faster. Cloud computing delivers additional speed, efficiently processing the scenarios needed to mitigate business risk even faster. Cloud has additional benefits: moving IT resources and applications to the cloud usually saves costs, improves security and better scales applications across the user base.

Though there is a general trend toward the cloud, there is no discrete formula for which organizations or applications should move to the cloud. Consider business benefits specifically for refinery and olefins planning so you can make an informed decision for your business.

**“Value capture is driven by obtaining new insights from deeper analysis of opportunities and decisions. Simply put: to do this, you need more cases. You can't make more time, so you must run them faster. Aspen PIMS-AO with parallel processing allowed us to run these cases 5-10 times faster.”**

**Senior Technology Advisor, Global Supermajor**



# Top Examples of Successful PIMS Cloud Deployment

## Example 1: Shell

- Single site, very large integrated refinery/chemicals complex (500+ kb/d)
- Stacks of 800-1700 cases for crude indifference value (CIV)
- Developed Excel front-end to set up the case stack, user “bursts” the job to cloud with the push of a button
- PIMS-AO and model are installed in the cloud
- Solve as a cloud burst (job and resource scheduling and prioritization)
- Result: about 5-20 times faster. **Previously took about 4 hours, now takes about 30 minutes.**



“Our economists would not finish their work on time. We had crude evaluation case sets of 800 or more at our large integrated refinery/chemical complexes. If the economists didn’t finish, they would take their heavy laptops home, then struggle with VPNs and slow network connections. Using the cloud solved these issues by making computing about 5-20 times faster. Additionally, increasing the scope of our analysis is expected to increase margins by about \$10M per year at these large complexes.”

Partha Sengupta, Principal Advisor, Manufacturing Margin Optimization, Shell

## Example 2: Reliance

- The largest refinery/chemicals complex in the world (1240 kb/d)
- Stacks of 400+ cases for crude indifference values, **solve in less than 10 minutes**



“As a part of continuous process improvement and pushing the boundaries of LP utilization, we took it to the next level by combining the advances in PIMS-AO software with new distributed processing algorithms on the cloud. This allows faster parallel processing. Deploying PIMS-AO on RIL Cloud platform for crude valuation has been successfully completed, and we are able to achieve crude valuation run time of 9 mins 36 secs for 322 cases.”

Anand Sansare, Planning Head, Reliance Industries Limited



# AspenTech Petroleum Supply Chain Cloud Offerings

There are several options for deploying the Aspen PIMS Family, either Aspen PIMS-AO or Aspen Unified PIMS.

## 1. Traditional installation – on-premises, also known as “local install”

- PIMS-AO installed on single laptop/desktop for each PIMS user

## 2. Clustering

- A centralized PIMS-AO installation on a local server or VM which is accessed via the company intranet or remote desktop. In this case, the computing power (number of cores) of the local server can be determined as needed. This is an example of a simple private cloud deployment.
- The benefit of the clustering example is that it improves efficiency while keeping costs reasonable. It is very costly to have a powerful computer (i.e. 16 core laptop) for each PIMS user with upgrade cost every few years.
- Additionally, the cluster or private cloud maintains security because it is all within your company intranet.

## 3. Cloud Bursting

- PIMS-AO installed on each desktop and multiple server nodes in the

cloud (private or public). Hardware is typically owned by the cloud provider (i.e. AWS or Microsoft Azure) and leased to the user as it is needed and used. For example, when you run your set of 1,000 cases, the cases are processed using the cloud server immediately.

- The previous examples from both Shell and Reliance demonstrate success with this method. The benefits are very fast speed with low up-front and on-going costs. It is also very easy to use – open PIMS-AO and select the “Use Cluster Configuration” feature. The downsides are like the clustering example #2 above that may require some effort to setup and does require a network connection to process cases.

## 4. Cloud Installation – Infrastructure as a Service (IaaS)

- AWS or Microsoft Azure remote cloud
- Resources would typically be off-prem
- Your company can choose public or private cloud
- Option to choose whether PIMS-AO is installed locally or in the cloud server
  - If installed locally, the cloud is only used to run the cases. You push a button saying “run in cloud” then the cases are “burst” into the cloud and solved on the off-prem cloud server, with parallel processing of 20, 40, or hundreds of cores.<sup>iii</sup>
  - If PIMS-AO is installed in the cloud, users access it via a remote desktop protocol (RDP) or similar.



# Deployment Options

## 1. Traditional Installation

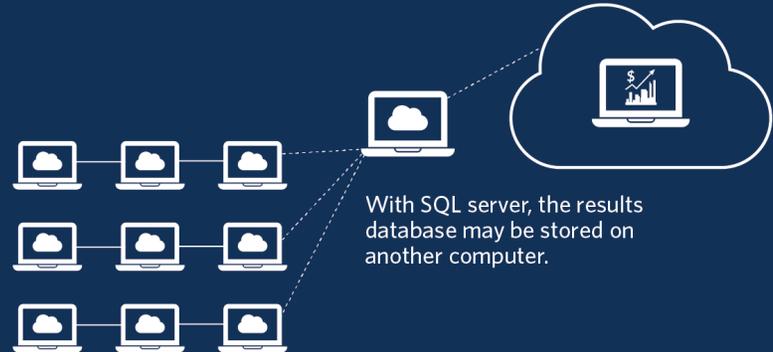
- PIMS AO is installed on a company's on-prem laptop.
- Cases run on the laptop using local CPU; the results database is stored on the laptop.
- Laptop CPU is used to solve the cases
- Results database stored in the laptop



Cloud is not utilized

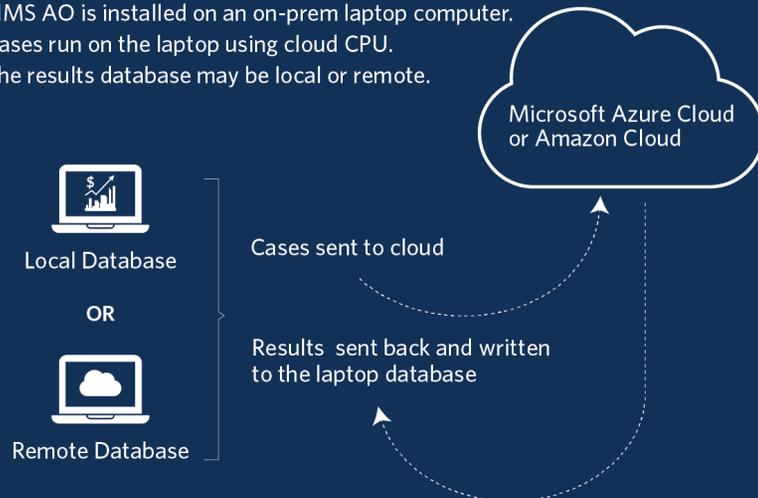
## 2. Clustering

- Use existing features of PIMS AO via cluster.
- Connect a planner's laptop with PIMS to a server located on-prem OR other laptops that may have extra/ idle CPUs.
- Users can define how many CPUs to use from other laptops without compromising other users' processing needs.



## 3. Cloud Bursting

- PIMS AO is installed on an on-prem laptop computer.
- Cases run on the laptop using cloud CPU.
- The results database may be local or remote.



## 4. PIMS AO Installed on the Cloud Instance

- Access the cloud via Remote Desktop Protocol (RDP)
- Users control the software in the cloud via the laptop client



PIMS is installed in the cloud environment, such as Microsoft Azure or Amazon Cloud

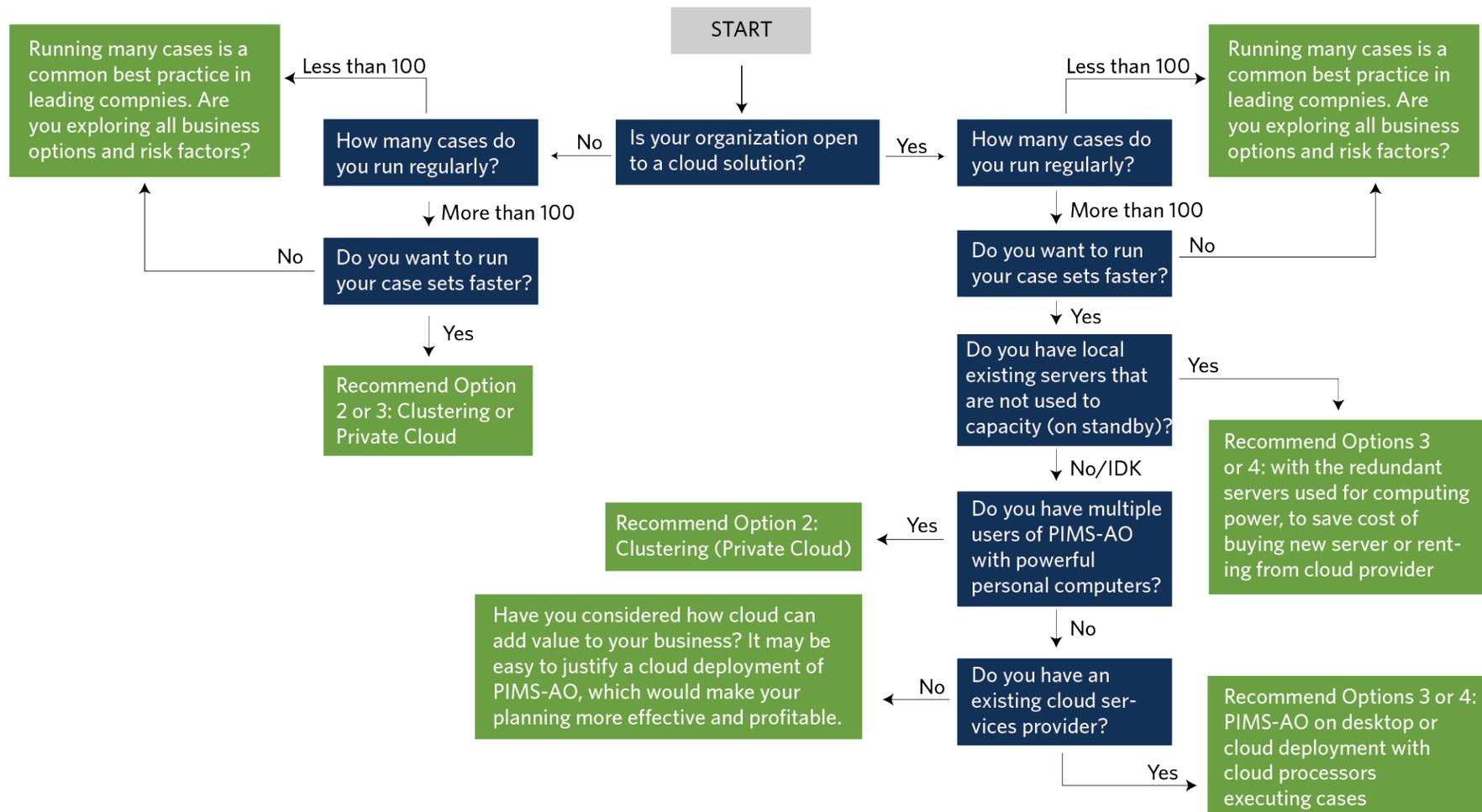


The results database is stored in the cloud; SQL server as a results database can be in another cloud deployment.

We strongly recommend SQL server for any PIMS client with large models or running tens of cases per period, because SQL allows simultaneous read/write/query vastly improves performances versus Access and SQL has no database size limits, whereas Access has a 2 GB database size limit.

To help you select a cloud architecture, we have developed the following flow chart. The options are described in detail in the table which follows.

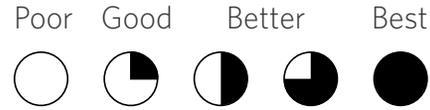
## Flowchart for Deployment Recommendations



## Table for Deployment Recommendations

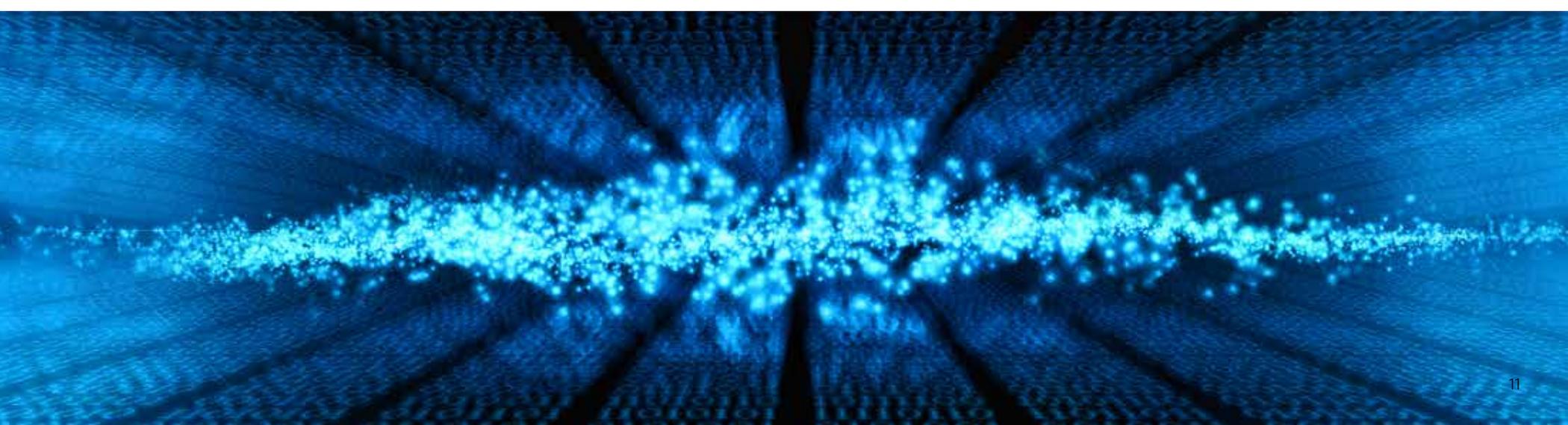
	Deployment Option	Pros	Cons	Recommended for	Example Clients
1	<b>Traditional installation</b> <ul style="list-style-type: none"> <li>PIMS-AO running on your personal computer</li> </ul>	<ul style="list-style-type: none"> <li>Simple to deploy and use</li> <li>You have full control of business process</li> <li>Can work offline if needed</li> <li>Easy to use – just open PIMS and click run. All the data required is on your PC.</li> </ul>	<ul style="list-style-type: none"> <li>Limited speed for large case sets</li> <li>Software is tied to a specific machine and user</li> <li>May be difficult to backfill</li> <li>Upgrading hardware costs</li> <li>May need to purchase multiple computers</li> </ul>	<ul style="list-style-type: none"> <li>Default setup / base case</li> </ul>	<ul style="list-style-type: none"> <li>Many examples</li> </ul>
2	<b>Clustering</b> <ul style="list-style-type: none"> <li>One or multiple company-owned servers on-premises for dedicated PIMS-AO execution</li> </ul>	<ul style="list-style-type: none"> <li>Fast processing of large case sets</li> <li>One-time cost</li> <li>No change to licensing / SLM server</li> <li>Users do not need powerful personal computers</li> <li>Easy to use – just open PIMS and click run. Select the option in PIMS-AO “Use Cluster Configuration.”</li> </ul>	<ul style="list-style-type: none"> <li>Higher up-front cost</li> <li>Upgrading hardware costs</li> <li>One-time deployment – must define the cluster setup</li> <li>Network connection required for large case sets</li> <li>Changing IP addresses at different network connections (LAN vs WAN vs VPN) may cause issues</li> </ul>	<ul style="list-style-type: none"> <li>Companies running 100s of cases regularly</li> <li>Those who already have hardware infrastructure, such as powerful redundant servers or powerful personal computers in a cluster</li> </ul>	<ul style="list-style-type: none"> <li>Integrated refinery/chemical company: 16-core, 3.8 GHz machine for each user. Having all these cores available supports cluster setup.</li> <li>Mid-size refinery: 32-core local backup SAP servers used for PIMS runs</li> </ul>
3	<b>Cloud Bursting</b> <ul style="list-style-type: none"> <li>PIMS-AO on your desktop with multiple server nodes in the cloud (private or public); hardware typically owned by the cloud provider (i.e. AWS/Azure)</li> </ul>	<ul style="list-style-type: none"> <li>Faster processing of large case sets</li> <li>Low up-front cost</li> <li>Hardware upgrading costs are on the cloud provider</li> <li>No change to licensing / SLM server</li> <li>Easy to use – just open PIMS and click run. Select the option in PIMS-AO “Use Cluster Configuration.”</li> </ul>	<ul style="list-style-type: none"> <li>One-time deployment – must define the cloud setup</li> <li>Network connection required for large case sets</li> <li>Higher ongoing cost</li> <li>Changing IP addresses at different network connections (LAN vs WAN vs VPN) may cause issues</li> </ul>	<ul style="list-style-type: none"> <li>Companies running 100s of cases regularly</li> <li>Those with existing contracts with a third-party cloud provider (i.e. AWS/Azure)</li> <li>Good network connectivity</li> </ul>	<ul style="list-style-type: none"> <li>Large refinery: 90-core server on premises, private cloud</li> </ul>
4	<b>Cloud Deployment</b> <ul style="list-style-type: none"> <li>All the compute servers including the parent PIMS-AO are installed on the public/private cloud</li> </ul>	<ul style="list-style-type: none"> <li>Fastest processing of large case sets</li> <li>Network connection not required during case execution/solving once the cases are submitted to the cloud</li> <li>Low up-front cost</li> <li>Hardware upgrading costs is on the cloud provider</li> </ul>	<ul style="list-style-type: none"> <li>Users may need to access PIMS-AO and all results via virtual desktop</li> <li>One-time deployment – must define the cloud setup</li> <li>Need to connect cloud PIMS-AO to SLM server</li> <li>Highest on-going cost</li> <li>Network must be reliable, but high-speed network is not required</li> <li>Changing IP addresses at different network connections (LAN vs WAN vs VPN) may cause issues</li> </ul>	<ul style="list-style-type: none"> <li>Companies running 100s of cases regularly</li> <li>Those with existing contracts with a third-party cloud provider (i.e. AWS/Azure)</li> <li>IT strategy / policies pro-cloud</li> <li>Companies aspiring to very thorough scenario analysis</li> <li>Companies significantly involved in trading who want to minimize risk</li> </ul>	<ul style="list-style-type: none"> <li>Supermajor: AWS</li> </ul>

# Deployment Option



Option	Speed	Ease of Setup	Ease of Use	Hardware Availability	IT Involvement	Cost - Setup	Cost - On-going (Hardware Maintenance and Replacement/Upgrade)
1 Local Install	Good	Best	Best	Best	Good	Better	Better
2 Cluster	Better	Better	Best	Better	Best	Best	Poor
3 Cloud Bursting	Best	Better	Best	Better	Best	Good	Best*
4 Cloud Deployment	Best	Better	Best	Better	Best	Good	Better

\* If your company has extra server capacity, then this could be very low cost. For example, a backup SAP server is minimum 32 cores. In our experience, most organization have these backup SAP servers. If you can work with your IT department to allow use of the backup SAP server to run PIMS cases, you can deploy option 3 at very little cost.



## About Aspen Technology

Aspen Technology (AspenTech) is a leading software supplier for optimizing asset performance. Our products thrive in complex, industrial environments where it is critical to optimize the asset design, operation and maintenance lifecycle. AspenTech uniquely combines decades of process modeling expertise with machine learning. Our purpose-built software platform automates knowledge work and builds sustainable competitive advantage by delivering high returns over the entire asset lifecycle. As a result, companies in capital-intensive industries can maximize uptime and push the limits of performance, running their assets safer, greener, longer and faster. Visit [AspenTech.com](https://www.aspentech.com) to find out more.

## References

- i [“Fourth Industrial Revolution Beacons of Technology and Innovations in Manufacturing.”](#) World Economic Forum, January 2019.
- ii [“Digitization, Digitalization and Digital Transformation: The Differences.”](#) I-Scoop.
- iii [“What is Cloud Computing? A Beginner’s Guide.”](#) Microsoft.

