

## Extending Enterprise Business Intelligence and Big Data to the Cloud

Access to multiple BI platforms—including cloud BI—gives flexible, powerful, affordable analytics capabilities to business units across Intel.

### Executive Overview

**Intel IT is incorporating cloud business intelligence (BI) into our overall enterprise BI strategy, enabling Intel business units (BUs) to perform and present analytics on data no matter where it resides—within the enterprise boundaries or outside.**

Cloud BI benefits Intel IT through faster deployment of solutions, more flexible capacity, faster and less expensive exploration of new technologies, as well as reduced capital, licensing, and maintenance costs. We estimate that using a cloud BI strategy can help avoid USD 1 to 2 million in annual costs associated with infrastructure and support (based on 2012 public-cloud pricing) and may reduce the time required to provision infrastructure services by 1 to 4 weeks.

The cloud offers Intel BUs a simple, managed environment for BI application development with an economical pay-as-you-go/pay-as-you-grow cost model. Because the cloud provider manages the infrastructure, BUs can focus on their core business strengths and bring the BI applications to market more quickly.

We have evaluated cloud BI and are engaged in positioning the BI tools that Intel is using or may use for cloud BI. The group has achieved the following:

- Developed a decision framework that can help us determine which usage pattern is most appropriate for a particular BI project
- Issued guidance on which cloud BI tools are appropriate based on market availability and existing investment
- Pinpointed the essential security and data-integration components associated with cloud BI

We plan to create guidelines for Intel's enterprise BI that cover these three models:

- Cloud BI solutions
- BI solutions that use a combination of on-premises physical servers and Intel's private cloud
- BI solutions that use on-premises physical servers only

Access to multiple BI platforms—including cloud BI—gives flexible, powerful, affordable analytics capabilities to BUs across Intel.

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- Identified three usage scenarios and 10 potential usage patterns for Intel's BI needs

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## BACKGROUND

**Intel's business units (BUs) are increasingly taking advantage of cloud-based software-as-a-service (SaaS) applications to meet their business requirements. Examples of such SaaS applications include customer relationship management, marketing automation, salesforce management, and human resources management. Because these SaaS applications are in the public cloud, Intel BUs are generating more data externally than on-premises.**

These BUs need to perform analytics on this external data just as they do for on-premises data. And often, they need to do it for a mix of the two types of data. Therefore, it is necessary to extend Intel IT's BI strategy to the cloud so that the analytic computing occurs where the data resides instead of having to move all data across the enterprise boundaries.

As shown in Figure 1, cloud BI involves all layers of the standard cloud model:

- **Software as a service (SaaS).** Enables BUs to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as from a web browser.

The BUs do not manage or control the underlying cloud infrastructure, including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

- **Platform as a service (PaaS).** Enables BUs to deploy their applications onto the cloud infrastructure. As with IaaS, the BUs do not manage or control the underlying cloud infrastructure but have control over the deployed applications and possibly over the configuration of application-hosting environments.
- **Infrastructure as a service (IaaS).** Enables BUs to provision processing, storage, networks, and other fundamental computing resources on which to deploy and run arbitrary software, which can include OSs and applications. The BUs do not manage or control the underlying cloud infrastructure but have control over OSs, storage, and deployed applications. However, the BUs' control of select networking components, such as host firewalls, may be limited.

Each layer corresponds to a subset of cloud BI capabilities—compute and storage in IaaS, data warehousing and integration in PaaS, and data visualization and analytics in SaaS.

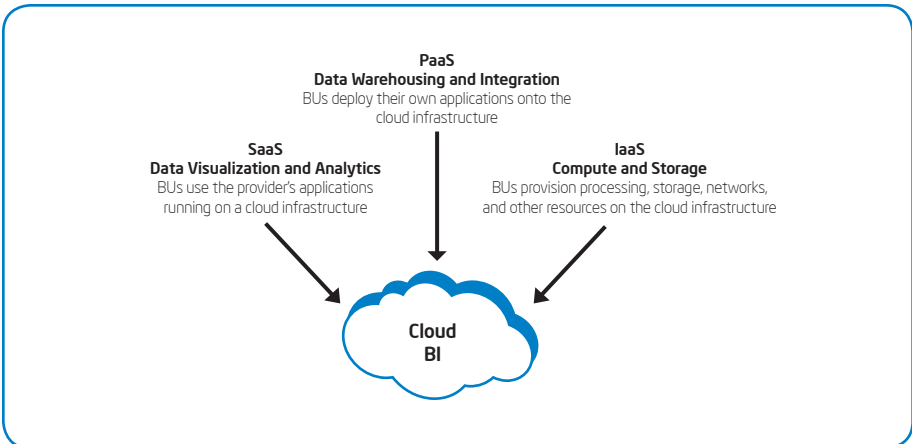


Figure 1. Cloud business intelligence (BI) takes advantage of the software-as-a-service (SaaS), platform-as-a-service (PaaS), and infrastructure-as-a-service (IaaS) capabilities in the cloud.

## Adding Cloud BI to Our Enterprise BI Portfolio

Intel IT provides an array of business intelligence (BI) platforms that enable Intel BUs to mine a broad range of data quickly, deeply, and cost-effectively. Cloud BI—defined as a BI, data integration, or data analytics platform deployed in the cloud (public or private)—is another option for enterprise BI. Adding cloud BI to Intel IT's overall strategy of providing multiple BI platforms is helping to enable BUs to solve more high-value business problems, achieve greater operational efficiencies, bring applications to market more quickly, and improve their competitive performance in global markets.

As shown in Figure 2, cloud BI provides a third facet for supporting Intel's enterprise integrated BI, complementing the existing two aspects of on-premises BI using physical servers (example platforms include enterprise data warehouses and custom data stores) and a combination of on-premises physical servers and virtual servers in Intel's enterprise private cloud, such as the internal big data platform (Intel® Distribution of Apache Hadoop® Software). For Intel, cloud BI comprises the BI applications and data hosted outside of the enterprise, generally using third-party public clouds.

BUs need a simple, managed environment for application development, an economical pay-as-you-go/pay-as-you-grow cost model, and the ability to focus on the core business, which does not usually include infrastructure management. For that reason, the following eight business requirements support the need for cloud BI at Intel (also summarized in Table 1):

- **Elastic.** The compute and storage demands associated with a BI solution are elastic—they often increase or decrease. With an on-premises solution, the supporting infrastructure is static, expensive and time-consuming to expand, and nearly impossible to reduce once it's deployed. In contrast,
- the cloud BI pay-per-use model enables a cloud BI solution to easily grow and shrink resources as necessary.
- **Agile.** Reduced time to market is a significant competitive advantage. Whether it's a BU deploying a new application or Intel IT conducting a proof of concept (PoC) to evaluate a new technology, cloud BI solutions enable speedy provisioning of necessary infrastructure. Sometimes it takes as little as 5 minutes to create a new environment.
- **Innovative.** The rapid evolution of BI and data analytics means that many new tools and technologies are being developed constantly. Cloud-based BI solutions enable timely access to these innovations without incurring the expense and effort of deploying them on-premises.
- **Accessible.** Users expect to access data anywhere, anytime. The web-based interface of cloud BI solutions helps provide this on-demand access.
- **Strategic.** From a strategic standpoint, cloud BI enables Intel organizations to concentrate on their core business goals.
- **Manageable.** With cloud BI, the cloud providers and suppliers manage the solution building blocks (such as upgrading the OS, refreshing hardware, or deploying a new version of a data analytics program).
- **Integrated.** As more data is generated off-premises, BUs need a way to integrate external data and internal data without compromising Intel's security and data governance guidelines.
- **Cost effective.** BUs—and Intel IT—need to keep the business running and provide better capabilities and toolsets while lowering the cost of solutions. Cloud BI solutions, which require little or no capital expenditures, are therefore often attractive from a cost perspective.

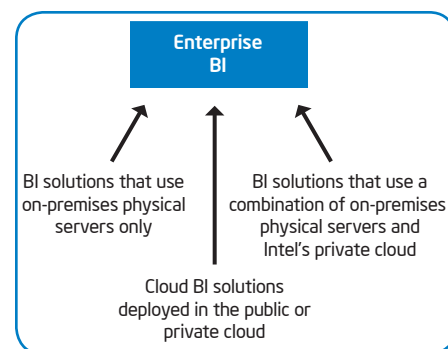


Figure 2. Access to multiple business intelligence (BI) platforms—including cloud BI—gives flexible, powerful, affordable analytics capabilities to business units (BUs) across Intel.

Table 1. Summary of Key Business Requirements Driving Intel's Adoption of Cloud Business Intelligence (BI)

BI Solution Requirements	Description
<b>Elastic</b>	Must grow and shrink infrastructure and compute resources on demand
<b>Agile</b>	Must enable business units (BUs) to deploy applications quickly
<b>Innovative</b>	Must give BUs access to new platforms and tools on demand
<b>Accessible</b>	Must provide anywhere/anytime access to BI data through a web interface
<b>Strategic</b>	Must enable BUs to focus on core strengths
<b>Manageable</b>	Must enable BUs to easily establish and manage BI solutions
<b>Integrated</b>	Must integrate external and internal data
<b>Cost effective</b>	Must have low total cost of ownership (TCO) and high return on investment (ROI)

Table 2. Estimated Cloud Business Intelligence (BI) Cost Savings

Cost Area	Estimated Savings
Infrastructure, provisioning, and support costs	We estimate a cost avoidance of USD 20,000 capital expenditure and USD 35,000 support expense per project. This could add up to USD 1 to 2 million annual cost avoidance (based on 2012 public-cloud pricing).
Time to market	We expect to reduce the time required to provision infrastructure and platform services by 1 to 4 weeks.
Impact to IT resources	Infrastructure management and production support accounts for 30 to 50 percent of IT's BI cost. Cloud BI could reduce this to 15 to 25 percent, enabling IT to focus more on core and strategic initiatives and provide cutting-edge technology exploration—thereby bringing additional value to Intel.

## Cloud BI Offers Significant Benefits

Both BUs and Intel IT—and therefore the entire enterprise—can benefit from integrating cloud BI solutions into Intel IT's overall BI solution portfolio. Outsourcing some BI services to the cloud can expedite service provisioning to the business; this outsourcing can also enable Intel IT to focus on innovation and deploy new, high-value capabilities.

For BUs, the primary benefits of cloud BI are reduced infrastructure, provisioning, and IT support costs, as well as faster execution of PoCs and exploratory activities.

For Intel IT, cloud BI can provide the following:

- Faster deployment of solutions
- Flexible capacity
- Faster and less expensive exploration of new technologies
- Reduced capital, licensing, and maintenance costs

Table 2 summarizes some of our estimated cost savings associated with cloud BI.

## EVALUATING CLOUD BI AT INTEL

Intel IT formed a group of experts from several Intel IT organizations to evaluate offerings and tools available in the cloud BI environment. This group's evaluation included solutions hosted in both public clouds and Intel's private cloud. As shown in Figure 3, our objective is to create guidelines for cloud BI and its positioning at Intel, then merge and extend existing IT BI portfolio offerings to include the public cloud.

To realize the benefits associated with cloud BI, we must know when to choose cloud BI instead of one of our other two enterprise BI aspects referenced in Figure 2. We have identified potential usage patterns for cloud BI at Intel and developed a decision framework that can help us determine which usage pattern best fits a particular BI project. However, even when a cloud BI solution is appropriate, we may decide to use some on-premises tools in order to maximize the value of a previous investment. We have also identified the essential security and data-integration components associated with cloud BI.

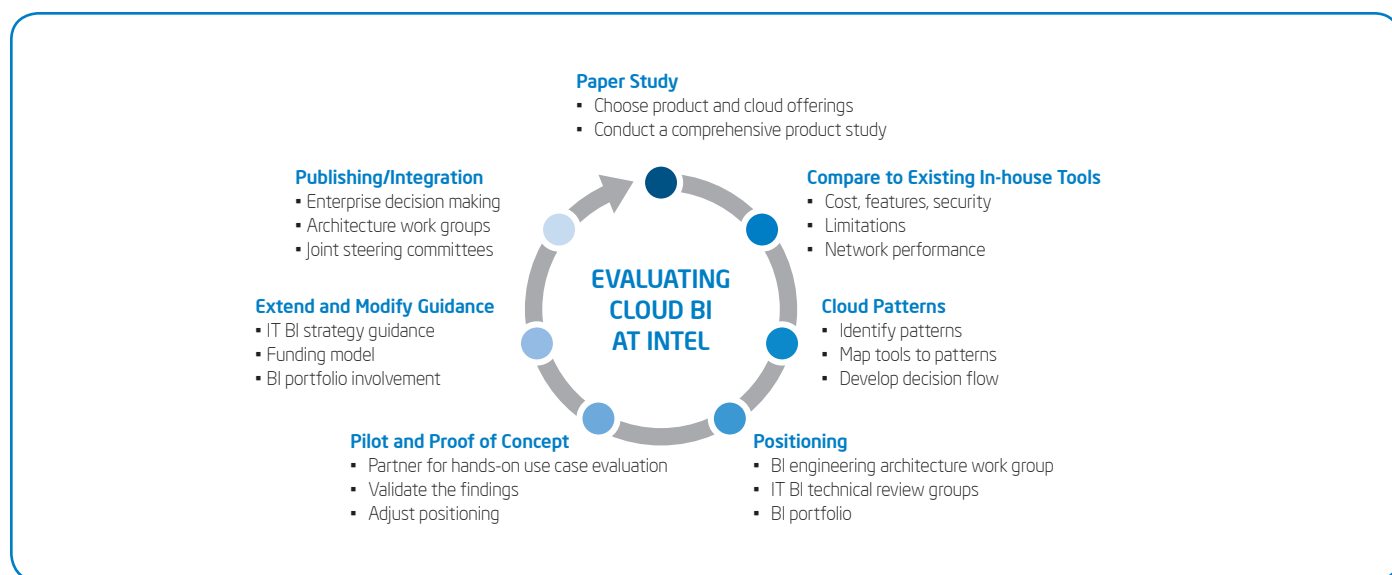


Figure 3. These guidelines helped a group of IT experts evaluate cloud business intelligence (BI) tools.

## Determining Cloud BI Usage Patterns

To fully understand how cloud BI could benefit Intel, we first needed to understand how it could be used. We identified three broadly defined cloud BI scenarios, illustrated in Figure 4. Each of the scenarios differs in the place the data is stored and the way it is consumed.

- **No integration.** In the left-hand scenario, no integration occurs between on-premises data and cloud data, and there is no shared interface between on-premises and cloud-based solutions.

- **Virtual integration.** In the middle scenario, the data is stored in the cloud and is integrated with on-premises data using a VPN. In this scenario, no data is physically moved.
- **Physical integration.** In the right-hand scenario, data integration occurs through physical movement of data.

Within these three scenarios, we identified 10 usage patterns that are applicable to Intel's BI environment, based on where the data is consumed, where the data and user-facing tools (UFTs) exist, and whether physical movement of data occurs. For

example, in a full-cloud solution with no integration (Patterns 1 and 2), both the data and tools are stored in the cloud, and the data is consumed in the cloud. A virtual integration (Patterns 5 and 6) could have the UFTs either in the cloud or on-premises, and data would reside both on-premises and in the cloud. There are more options for physical integration (Patterns 7 and 8), depending on whether the data moves from the cloud to the premises, or from the premises to the cloud. The usage patterns are illustrated in Table 3.

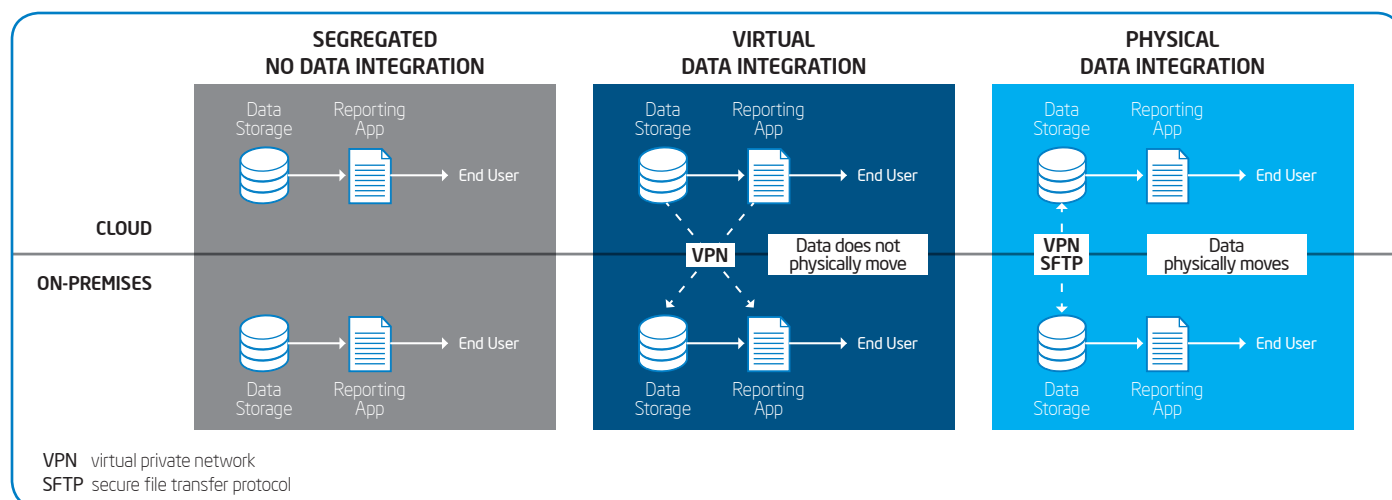


Figure 4. Cloud business intelligence (BI) can be characterized by no integration, virtual integration, or physical integration.

Table 3. Cloud Business Intelligence (BI) Usage Patterns for Data and User-Facing Tools (UFTs)

CLOUD CONSUMPTION

PATTERN 1: NO DATA INTEGRATION Full Cloud		PATTERN 3: PHYSICAL INTEGRATION		PATTERN 5: VIRTUAL INTEGRATION		PATTERN 7: PHYSICAL INTEGRATION		PATTERN 9: NO DATA INTEGRATION	
CLOUD	ON-PREMISES	CLOUD	ON-PREMISES	CLOUD	ON-PREMISES	CLOUD	ON-PREMISES	CLOUD	ON-PREMISES
UFT		UFT		UFT		UFT		UFT	
DATA		DATA MOVES FROM ON-PREMISES TO CLOUD		DATA	DATA	DATA MOVES FROM CLOUD TO ON-PREMISES			DATA

ON-PREMISES CONSUMPTION

PATTERN 2: NO DATA INTEGRATION		PATTERN 4: PHYSICAL INTEGRATION		PATTERN 6: VIRTUAL INTEGRATION		PATTERN 8: PHYSICAL INTEGRATION		PATTERN 10: NO DATA INTEGRATION Full On-Premises	
CLOUD	ON-PREMISES	CLOUD	ON-PREMISES	CLOUD	ON-PREMISES	CLOUD	ON-PREMISES	CLOUD	ON-PREMISES
	UFT		UFT		UFT		UFT		UFT
DATA		DATA MOVES FROM ON-PREMISES TO CLOUD		DATA	DATA	DATA MOVES FROM CLOUD TO ON-PREMISES			DATA

Table 4. Considerations for Determining Whether Cloud Business Intelligence (BI) Is Appropriate

Cloud BI may be appropriate	Cloud BI may not be appropriate
Required technologies are not already hosted	Required technologies are already hosted in the enterprise
Processes, applications, and data are largely independent	Processes, applications, and data are largely coupled and most data is already on-premises
Points of integration are well defined	Points of integration are not well defined
A lower level of security is adequate	High-level security is required, or the data classification requires the data be kept on-premises
Web is the desired platform	Applications require native interfaces
Agility and elasticity are critical	Enterprise-level performance is critical
Cost is an issue	Legacy applications are involved
Applications are new and hosting skills are non-existent	Desired products are not available in a cloud-hosted environment

Table 5. Questions Used to Determine the Most Appropriate Cloud Business Intelligence (BI) Usage Pattern

Questions	Possible Answers
What is the primary source of data?	<ul style="list-style-type: none"><li>Cloud</li><li>On-premises</li></ul>
Is the data integrated with the cloud?	<ul style="list-style-type: none"><li>Yes</li><li>No</li></ul>
Are desired features and functionality available?	<ul style="list-style-type: none"><li>Cloud</li><li>On-premises</li></ul>
Where will the user-facing tools (UFTs) and data be consumed?	<ul style="list-style-type: none"><li>Cloud</li><li>On-premises</li></ul>
Is performance or freshness of data more important?	<ul style="list-style-type: none"><li>Fresh data with virtual integration</li><li>High performance with physical integration on-premises</li></ul>
Are cost, volume, and performance features critical?	<ul style="list-style-type: none"><li>Yes</li><li>No</li></ul>
What is the nature of the project?	<ul style="list-style-type: none"><li>Temporary (proof of concept or evaluation)</li><li>Permanent (business unit project)</li></ul>

Choosing the Right Usage Pattern for the Use Case

Sometimes, other options are more appropriate than using a cloud BI offering. Table 4 summarizes our conclusions about when cloud BI is appropriate. Generally, we recommend that BUs do not use a cloud BI offering just because it is available. The BUs need to determine if the cloud BI offering is going to be cost effective, if the required skill set is going to be sustainable, and if the platform and technology is supportable.

For those projects where cloud BI is a good fit, we have developed a decision framework that pinpoints the most appropriate cloud BI usage pattern based on the answers to a series of questions (see Table 5). This approach makes it easier to select a cloud BI solution and standardizes the process for the enterprise.

Figure 5 illustrates two examples of using the questions to arrive at several usage patterns.

In Example 1, the data is on-premises. If data integration with the cloud is not required, the decision framework indicates usage pattern #9 (UFTs in the cloud, data on-premises) or usage pattern #10 (UFTs and data on-premises). If integration and fresh data are required, the decision framework results in usage pattern #6 (UFTs on-premises, data both on-premises and in the cloud).

In Example 2, the data is in the cloud. If integration is required and performance is a top priority, the decision framework results in usage pattern #4 (UFTs on-premises, data in both places with movement from on-premises to the cloud). But if integration is not required, either usage pattern #1 (UFTs and data in the cloud) or #2 (UFTs on-premises, data in the cloud) could be appropriate, depending on how critical cost, volume, and performance features are.

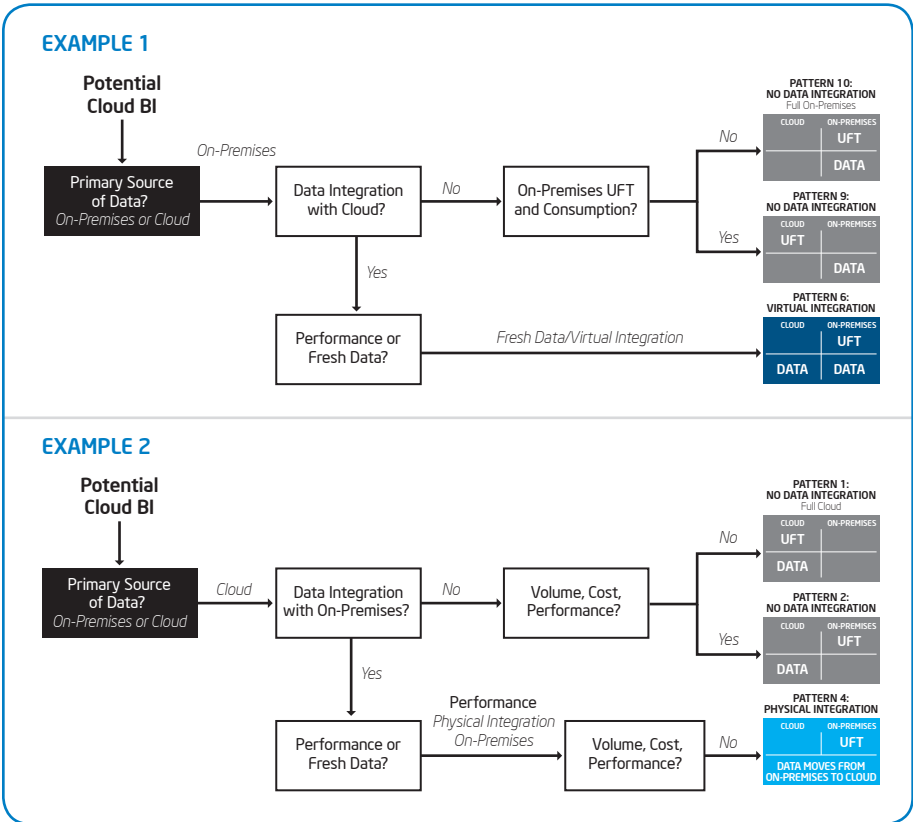


Figure 5. Our cloud business intelligence (BI) decision framework helps determine the best usage pattern for a particular use case.



It is important to note that, although not directly illustrated in the examples in Figure 5, the decision framework is actually more of a conceptual circle. That is, traversing one path (such as cloud-only or on-premises-only) in the decision framework may result in switching to the other side if certain criteria are met. For example, if the cost is too high or the performance is too degraded in the cloud, the decision framework will direct the decision maker back to the on-premises path.

## Surveying the Available Tools

For each usage pattern there is a certain set of tools and products available from a variety of cloud providers and application suppliers:

- User-facing, reporting, processing, and analytical tools
- Storage platforms, including data warehouses, databases, and unstructured data containers
- Data integration tools for the usage patterns involving physical data movement
- Connectivity options, including corporate network, public network, or open VPN

In some cases an existing investment in a tool that is part of Intel's plan of record (PoR) may supersede the decision to use other available tools. For example, if an adequate data analysis tool is already part of the PoR, then it may not be appropriate to invest in another product just because it is available in the cloud. We recommend that a cloud BI solution use new cloud-based tools only if the PoR tools do not meet business requirements or provide the necessary capabilities.

## Security and Data Integration Considerations

Cloud computing can help reduce costs, increase business agility, and enable IT to focus on projects with a high return on investment (ROI). As we continue to explore the use of cloud BI at Intel, we also realize the ongoing need to protect data according to Intel information security policies and to safely and efficiently integrate data.

### SECURITY

The implementation of a security solution varies for each of the 10 cloud BI usage patterns we identified. However, all 10 usage patterns share the following security components:

- **User authentication**, which helps validate users' identities
- **Entitlement capabilities**, which control users' access to data files and in some cases restrict access to certain rows and columns
- **User-group-management capabilities**, which enable efficient integration and management of on-premises user permissions and entitlements, such as integration with directory services and protocols

### DATA INTEGRATION

Performing a preliminary evaluation can help us understand the challenges associated with data integration between the cloud and on-premises environments. Data integration can be difficult due to a number of factors including but not limited to data classification, data volume, and data latency. Near-real-time information requirements can make virtual data integration the best approach, whereas performance and cost requirements can make physical data integration a better approach.

However, these requirements often overlap and contradict each other, so it is important to find an appropriate balance between the most appropriate data integration methods.

For example, physical data movement from one environment to another can increase the analysis performance but may not be cost effective and may pose security risks that must be mitigated by encrypting and securing in-flight data. Or, virtual data integration may effectively limit how much data can be reasonably integrated. We also consider data-life-cycle management, as it dictates how much data we retain and how often it is purged.

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## NEXT STEPS

**Having identified cloud BI usage patterns, we are now engaged in classifying the products and tools available in the market and determining which ones may be used in Intel IT's BI environment. Each use case needs its own analysis before we can determine the best-fit usage pattern and best cloud BI offerings.**

We will conduct PoCs and pilot projects to validate what we discovered about usage patterns. We also plan to integrate cloud BI guidelines into our existing enterprise BI guidelines, which will help enable BUs to choose the BI aspect that best fits their needs and that provides the highest value to the enterprise. We have taken a prescriptive approach to designing the decision framework to direct BI use cases to the cloud. We will continue to refine the decision criteria as more PoCs and pilots test the rigor of our framework.

## CONCLUSION

**Intel's BUs are generating increasing amounts of external data using cloud-based SaaS applications. To make it more efficient for these BUs to perform analytics on this data, Intel IT is incorporating cloud BI into Intel's overall enterprise BI strategy.**

The entire enterprise can benefit from integrating cloud BI solutions into the BI portfolio. The BUs benefit by reducing infrastructure and IT support costs, speeding the execution of PoCs and exploratory activities, and bringing applications to market more quickly. For Intel IT, cloud BI can provide faster deployment of solutions, flexible capacity, faster and less expensive exploration of innovative technologies, as well as reduced capital, licensing, and maintenance costs.

The Intel IT cloud BI evaluation team plans to create a single integrated set of guidelines that apply to these three models:

- Cloud BI
- A combination of on-premises physical servers and Intel's private cloud
- On-premises physical servers only

We have identified 10 cloud BI usage patterns in the Intel environment. These patterns represent different combinations of where the data is consumed (in the cloud or on-premises), where the UFTs and data reside, and whether the data is physically moved. We have also developed a decision

framework based on questions that help pinpoint the most appropriate cloud BI usage pattern for a particular use case.

By adding cloud BI to the existing set of BI platforms, Intel IT is enabling Intel BUs to mine a broader range of data—quickly, deeply, and cost-effectively. This expanded architecture enables BUs to solve more high-value business problems, achieve greater operational efficiencies, and improve their competitive performance in global markets.

## RELATED INFORMATION

Visit [www.intel.com/IT](http://www.intel.com/IT) to find content on related topics:

- "Broadening Access to Advanced Analytics in the Enterprise"
- "Cloud Computing Cost: Saving with a Hybrid Model"
- "Configuring an In-Memory BI Platform for Extreme Performance"
- "Developing a Highly Available, Dynamic Hybrid Cloud Environment"
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## ACRONYMS

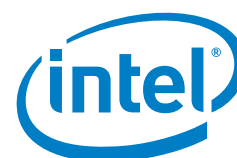
BI	business intelligence
BU	business unit
IaaS	infrastructure as a service
PoC	proof of concept
PaaS	platform as a service
PoR	plan of record
ROI	return on investment
SaaS	software as a service
TCO	total cost of ownership
UFT	user-facing tools

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