Chapter 1

Introducing Power BI

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Without supporting data, you are just another person with an opinion. But data is useless if you can't derive knowledge from it. And, this is where Microsoft data analytics and Power BI can help! Power BI changes the way you gain insights from data; it brings you a cloud-hosted, business intelligence and analytics platform that democratizes and opens BI to everyone. Power BI makes data analytics pervasive and accessible to all users under a simple promise "five seconds to sign up, five minutes to wow!"

This guide discusses the capabilities of Power BI, and this chapter introduces its innovative features. I'll start by explaining how Power BI fits into the Microsoft Data Platform and when to use it. You'll learn what Power BI can do for different types of users, including business users, data analysts, professionals, and developers. I'll also take you on a tour of the Power BI features and its toolset.

1.1 What is Microsoft Power BI?

Before I show you what Power BI is, I'll explain business intelligence (BI). You'll probably be surprised to learn that even BI professionals disagree about its definition. In fact, Forester Research offers two definitions (see https://en.wikipedia.org/wiki/Business_intelligence).

DEFINITION Broadly defined, BI is a set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information that's used to enable more effective strategic, tactical, and operational insights and decision-making. A narrower definition of BI might refer to just the top layers of the BI architectural stack, such as reporting, analytics, and dashboards.

Regardless of which definition you follow, Power BI can help you with your data analytics needs.

1.1.1 Understanding Business Intelligence

The definition above is a good a starting point but to understand BI better, you need to understand its flavors. First, I'll categorize who's producing the BI artifacts, and then I'll show you the different types of analytical tasks that these producers perform.

Understanding BI usage scenarios

I'll classify BI by its main users and produced artifacts and divide it into self-service, team, and organizational BI.

- Self-service BI (or personal BI) – Self-service BI enables data analysts to offload effort from IT pros. From example, Maya is a business user and she wants to analyze CRM data from Salesforce. Maya can connect to Salesforce and get prepackaged dashboards and reports without building a data model. In the more advanced scenario, Power BI empowers analysts to build data models for self-service data exploration and reporting. Suppose that Martin from the sales department wants to analyze some sales

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data that's stored in a Microsoft Access database or in an Excel workbook. With a few clicks, Martin can import the data from various data sources into a data model (similar to the one shown in **Figure 1.1**), build reports, and gain valuable insights. In other words, Power BI opens makes data analytics more pervasive because it enables more employees to perform BI tasks.

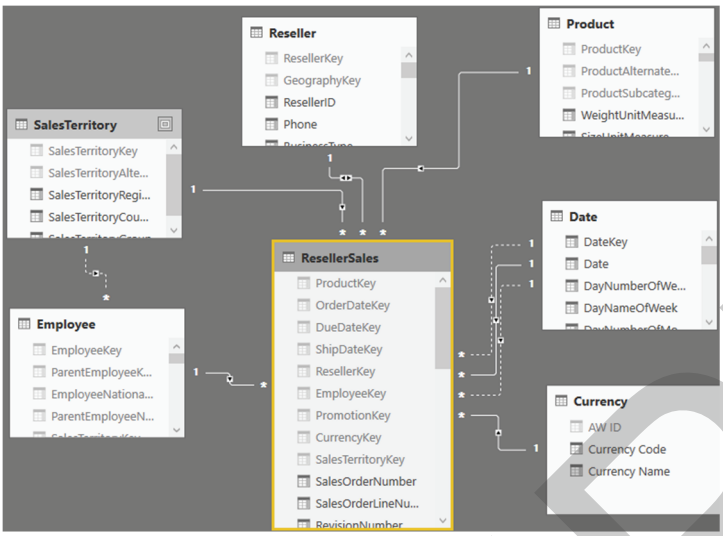

Figure 1.1 Power BI allows business users to build data models whose features are on par with professional models implemented by BI pros.

- Team BI – Business users can share the reports and dashboards they've implemented with other team members without requiring them to install modeling or reporting tools. Suppose that Martin would like to share his sales model with his coworker, Maya. Once Martin has uploaded the model to Power BI, Maya can go online and view the reports and dashboards Martin has shared with her. She can even create her own reports and dashboards that connect to Martin's model.
- Organizational BI (or corporate BI) – BI professionals who implement Microsoft SQL Server Analysis Services Multidimensional and Tabular models will find that Power BI allows them to implement hybrid solutions that eliminate the need to move data to Power BI. For example, as a BI pro, Elena has developed a Multidimensional or Tabular model layered on top of the company's data warehouse. Elena can install connectivity software on an on-premises computer so that Power BI can connect to her model. This allows business users to create instant reports and dashboards in Power BI by leveraging the existing investment in Analysis Services without moving data to the cloud!

NOTE To learn more about Analysis Services, I covered implementing Analysis Services Multidimensional models in my books "Applied Microsoft Analysis Services 2005" and Tabular models in "Applied Microsoft SQL Server 2012 Analysis Services: Tabular Modeling".

Understanding types of data analytics

The main goal of BI is to get actionable insights that lead to smarter decisions and better business outcomes. There are three types of data analytics (descriptive, predictive, and prescriptive) that can help users achieve this goal.

Descriptive analytics is retrospective. It focuses on what has happened in the past to understand the company's performance. This type of analytics is the most common and well understood. Coupled with a good data exploration tool, such as Power BI or Microsoft Excel, descriptive analytics helps you discover import trends and understand the factors that led to these trends. You do descriptive analytics when you slice and dice data. For example, a business analyst can create a Power BI report to discover sale trends by year. Descriptive analytics can answer questions, such as "Who are my top 10 customers?", "What is the

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company's sales by year, quarter, month, and so on?", "How does the company's profit compare against the predefined goal by business unit, product, time, and other subject areas?"

Predictive analytics is concerned with what will happen in the future. It uses data mining and machine learning algorithms determine probable future outcomes and discover patterns that might not be easily discernible based on historical data. These hidden patterns can't be discovered with traditional data exploration since data relationships might be too complex or because there's too much data for a human to analyze. Typical data mining tasks include forecasting, customer profiling, and basket analysis. Data mining can answer questions, such as, "What are the forecasted sales numbers for the next few months?", "What other products is a customer likely to buy along with the product he or she already chose?", and, "What type of customer (described in terms of gender, age group, income, and so on) is likely to buy a given product?" As it stands Power BI doesn't have native predictive capabilities but it can be integrated with other services and products, such as Azure Machine Learning and R. For example, an analyst can build a predictive model with the Azure Machine Learning service and then visualize the results in Power BI. Or, he can import forecasted data from an R script and then present it on a Power BI report.

Finally, *prescriptive analytics* goes beyond predictive analytics to not only attempt to predict the future but also recommend the best course of action and the implications of each decision option. Typical prescriptive tasks are optimization, simulation, and goal seek. While tools for descriptive and predictive needs have matured, prescriptive analytics is a newcomer and currently is in the realm of startup companies. The good news is that you can get prepackaged advanced analytics and prescriptive solutions with Cortana Analytics Suite, such as solutions for product recommendations and customer churn. In July 2015, Microsoft unveiled Cortana Analytics Suite as "a fully managed big data and advanced analytics suite that enables you to transform your data into intelligent action". The suite includes various cloud-based services, such as Azure Machine Learning for predictive analytics, Stream Analytics for real-time BI, and Power BI for dashboards and reporting. I'll show you some of these capabilities, including the Cortana digital assistant in Chapter 3, and Azure Machine Learning and Stream Analytics in Chapter 10.

1.1.2 Introducing the Power BI Products

Now that you understand BI better, let's discuss what Power BI is. Power BI is a set of products and services that enables you to connect to your data, visualize it, and share insights with other users. At a high level. Power BI consists of three products:

- Power BI Service – A *cloud-based* business analytics service (powerbi.com) that allows you to host your data, reports and dashboards online and share them with your coworkers. Because Power BI is hosted in the cloud and maintained by Microsoft, your organization doesn't have to purchase, install, and maintain an on-premises infrastructure. Microsoft delivers weekly updates to the Power BI Service so the pace of innovation and improvement will continue unabated. To stay up to date with the latest features, follow the Power BI blog (http://blogs.msdn.com/b/powerbi).
- Power BI Mobile – A set of native applications for iOS, Android, and Windows that allow users to use mobile devices, such as tablets and smartphones, to get data insights on the go. For example, a mobile user can view and interact with reports and dashboards deployed to Power BI.
- Power BI Desktop – A freely available Windows desktop application that allows analysts to design data models and reports. For readers familiar with Power Pivot for Excel, Power BI Desktop offers similar self-service BI features in a standalone application outside Excel.

DEFINITION Microsoft Power BI is a data analytics platform for self-service, team, and organizational BI that consists of Power BI Service, Power BI Mobile and Power BI Desktop products. Sometimes referred to as Power BI 2.0, it replaces Power BI for Office 365, and it doesn't require an Office 365 subscription.

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As you could imagine, Power BI is a versatile platform that enables different groups of users to implement a wide range of BI solutions depending on the task at hand.

1.1.3 How Did We Get Here?

Before I delve into the Power BI capabilities, let's step back for a moment and review what events led to its existence. **Figure 1.2** shows the major milestones in the Power BI journey.

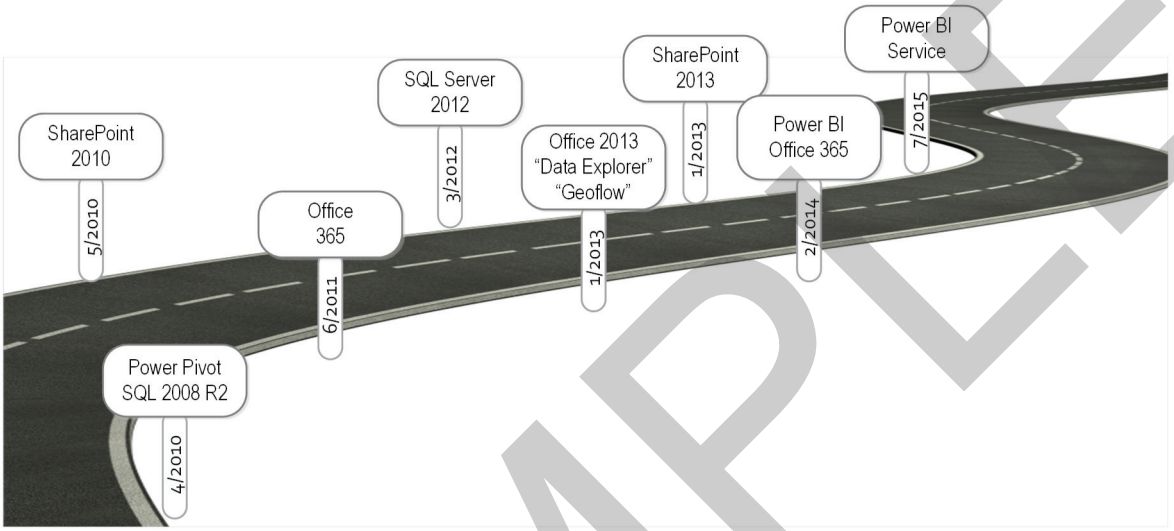

Figure 1.2 Important milestones related to Power BI.

Power Pivot

Realizing the growing importance of self-service BI, in 2010 Microsoft introduced a new technology for personal and team BI called PowerPivot (renamed to Power Pivot in 2013 as a result of Power BI rebranding). Power Pivot was initially implemented as a freely available add-in to Excel 2010 that had to be manually downloaded and installed. Office 2013 delivered deeper integration with Power Pivot, including distributing it with Excel 2013 and allowing users to import data directly into the Power Pivot data model.

NOTE I covered Excel and Power Pivot data modelling in my book "Applied Microsoft SQL Server 2012 Analysis Services: Tabular Modeling". Although the book targets Excel 2010, it should give you the necessary foundation to understand Power Pivot and learn how to use it to implement self-service data models and how to integrate them with SharePoint Server.

The Power Pivot innovative engine, called xVelocity, transcended the limitations of the Excel native pivot reports. It allows users to load multiple datasets and import more than one million rows (the maximum number of rows that can fit in an Excel spreadsheet). xVelocity compresses the data efficiently and stores it in the computer's main memory. For example, using Power Pivot, a business user can import data from a variety of data sources, relate the data, and create a data model. Then the user can create pivot reports or Power View reports to gain insights from the data model.

DEFINITION xVelocity is a data engine that compresses and stored data in memory. Originally introduced in Power Pivot, the xVelocity data engine has a very important role in Microsoft BI. xVelocity is now included in other Microsoft offerings, including SQL Server columnstore indexes, Tabular models in Analysis Services, Power BI Desktop, and Power BI.

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SQL Server

Originally developed as a relational database management system (RDBMS), Microsoft SQL Server is now a multi-product offering. In the context of organizational BI, SQL Server includes Analysis Services which has traditionally allowed BI professionals to implement multidimensional cubes. SQL Server 2012 introduced another path for implementing organizational models called Tabular. Think of Analysis Services Tabular as Power Pivot on steroids. Just like Power Pivot, Tabular allows you to create in-memory data models but it also adds security and performance features to allow BI pros to scale these models and implement data security that is more granular.

SQL Server includes also Reporting Services which has been traditionally used to implement paper-oriented standard reports. However, SQL Server 2012 introduced a SharePoint 2010-integrated reporting tool, named Power View, for authoring ad hoc interactive reports. Power View targets business users without requiring query knowledge and report authoring experience. Suppose that Martin has uploaded his Power Pivot model to SharePoint Server. Now Maya (or anyone else who has access to the model) can quickly build a great-looking tabular or chart report in a few minutes to visualize the data from the Power Pivot model. Or, Maya can use Power View to explore data in Multidimensional or Tabular organizational model.

In Office 2013, Microsoft integrated Power View with Excel 2013 to allow business users to create interactive reports from Power Pivot models and organizational Tabular models. And Excel 2016 extended Power View to connect to multidimensional cubes. This enhanced version of Power View enables reports and dashboards in Power BI.

SharePoint Server

Up to the release of Power BI, Microsoft BI has been intertwined with SharePoint. SharePoint Server is a Microsoft on-premises product for document storage, collaboration, and business intelligence. In SharePoint Server 2010, Microsoft added new services, collectively referred to as Power Pivot for SharePoint, which allowed users to deploy Power Pivot data models to SharePoint and then share reports that connect to these data models. For example, a business user can upload the Excel file containing a data model and reports to SharePoint. Authorized users can view the embedded reports and create their own reports.

SharePoint Server 2013 brought better integration with Power Pivot and support for data models and reports created in Excel 2013. When integrated with SQL Server 2012, SharePoint Server 2013 offers other compelling BI features, including deploying and managing SQL Server Reporting Services (SSRS) reports, team BI powered by Power Pivot for SharePoint, and PerformancePoint Services dashboards.

Microsoft Excel

While SharePoint Server has been the Microsoft premium server-based platform for BI, Microsoft Excel has been their premium BI tool on the desktop. Besides Power Pivot and Power View, which I already introduced, Microsoft added other BI-related add-ins to extend the Excel data analytics features. To help end users perform predictive tasks in Excel, Microsoft released a Data Mining add-in for Microsoft Excel 2007, which is also available with newer Excel versions. For example, using this add-in an analyst can perform a market basket analysis, such as to find which products customers tend to buy together.

NOTE In 2014, Microsoft introduced a cloud-based Azure Machine Learning Service (http://azure.microsoft.com/en-us/services/machine-learning) to allow users to create predictive models in the cloud, such as a model that predicts the customer churn probability. Azure Machine Learning supersedes the Data Mining add-in for self-service predictive analytics.

In January 2013, Microsoft introduced a freely available Data Explorer add-in, which was later renamed to Power Query. Unique in the self-service BI tools market, Power Query allows business users to transform and cleanse data before it's imported. For example, Martin can use Power Query to replace wrong values in the source data or to un-pivot a crosstab report. In Excel, Power Query is an optional path for import-

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ing data. If data doesn't require transformation, a business user can directly import the data using the Excel or Power Pivot data import capabilities. However, Power BI always uses Power Query when you import data so that its data transformation capabilities are there if you need them.

Another data analytics add-in that deserves attention is Power Map. Originally named Geoflow, Power Map is another freely available Excel add-in that's specifically designed for geospatial reporting. Using Power Map, a business user can create interactive 3D maps, such as the one shown in **Figure 1.3**. In this case, Power Map is used to analyze the correlation of power consumption and the age of the buildings in a particular geographic region. You can get some of the Power Map capabilities in Power BI when you import the GlobeMap custom visual from the Power BI visual gallery (http://visual.powerbi.com).

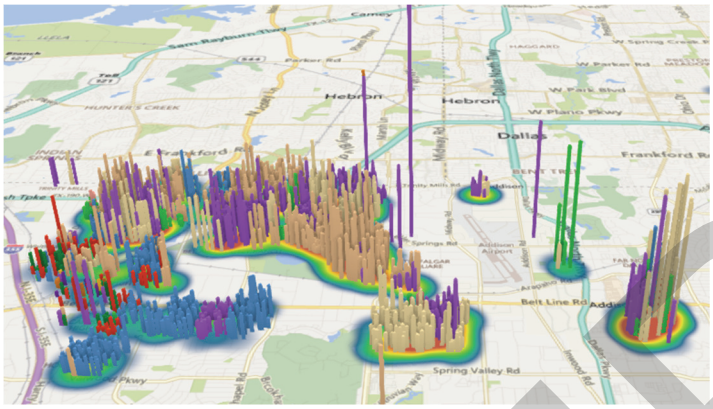

Figure 1.3 A free Excel add-in, Power Map enables you to analyze geospatial data by creating 3D visualizations with Bing maps.

Power BI for Office 365

Unless you live under a rock, you know that one of the most prominent IT trends nowadays is toward cloud computing. Chances are that your organization is already using the Microsoft Azure Services Platform - a Microsoft cloud offering for hosting and scaling applications and databases through Microsoft datacenters. Microsoft Azure gives you the ability to focus on your business and to outsource infrastructure maintenance to Microsoft.

In 2011, Microsoft unveiled its Office 365 cloud service to allow organizations to subscribe to and use a variety of Microsoft products online, including Microsoft Exchange and SharePoint. For example, at Prologika we use Office 365 for email, a subscription-based (click-to-run) version of Microsoft Office, OneDrive for Business, Skype for Business, and other products. From a BI standpoint, Office 365 allows business users to deploy Excel workbooks and Power Pivot data models to the cloud. Then they can view the embedded reports online, create new reports, and share BI artifacts with other users.

In early 2014, Microsoft further extended SharePoint for Office 365 with additional BI features, including natural queries (Q&A), searching and discovering organizational datasets, and mobile support for Power View reports. Together with the "power" desktop add-ins (Power Pivot, Power View, Power Query, and Power Map), the service was marketed and sold under the name "Power BI for Office 365". While the desktop add-ins were freely available, Power BI for Office 365 required a subscription. Microsoft sold Power BI for Office 365 independently or as an add-on to Office 365 business plans.

Power BI for Office 365 eliminated the need to host SharePoint Server on premises. For example, if Martin's organization didn't want to install and maintain SharePoint on premises, they could purchase a Power BI for Office 365 subscription plan. This allows Martin to deploy and share Power Pivot data models, just like he can do by deploying them to SharePoint Server on premises. Surpassing the SharePoint Server BI capabilities, Power BI for Office 365 also allows business users to type in natural queries to gain insights from Martin's data model, such as "show me sales by year". Behind the scenes, Power BI for Office 365 would interpret the question and use a suitable Power View visualization to display the results.

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Data discovery is a big issue with larger organizations. Another feature of Power BI for Office 365 is sharing and discovering Power Query-based datasets. It allows a data steward to publish curated queries, such as a query that returns a list of the company's products (only the query is published, not the data). Then, other users can search and discover this query, and then use it to import the list of products in their self-service data model.

NOTE In July 2015, Microsoft introduced a new cloud service outside Office 365, called Azure Data Catalog (http://azure.microsoft.com/en-us/services/data-catalog). This service extends Power Query dataset sharing and discovery.

Power BI Service (Power BI 2.0)

Finally, the winding road brings us to Power BI which is the subject of this book. In July 2015, after several months of public preview, Microsoft officially launched a standalone version of Power BI (initially referred to as Power BI 2.0) that had no dependencies on Office 365, SharePoint and Microsoft Office. What caused this change? The short answer is removing adoption barriers for both Microsoft and consumers. For Microsoft it became clear that to be competitive in today's fast-paced marketplace, its BI offerings can't depend on other product groups and release cycles. Waiting for new product releases on two and three-year cadences couldn't introduce the new features Microsoft needed to compete effectively with "pure" BI vendors (competitors who focus only on BI tools) who have entered the BI market in the past few years.

After more than a decade working with different BI technologies and many customers, I do believe that Microsoft BI is the best and most comprehensive BI platform on the market! But it's not perfect. One ongoing challenge is coordinating BI features across product groups. Take for example SharePoint, which Microsoft promoted as a platform for sharing BI artifacts. Major effort underwent to extend SharePoint with SSRS in SharePoint integration mode, PerformancePoint, Power Pivot, and so on. But these products are owned by different product groups and apparently coordination has been problematic. For example, after years of promises for mobile rendering, Power View in SharePoint Server still requires Microsoft Silverlight for rendering, thus barring access from non-Windows devices.

Seeking a stronger motivation for customers to upgrade, Excel added the "power" add-ins and was promoted as the Microsoft premium BI tool on the desktop. However, the Excel dependency turned out to be a double-edge sword. While there could be a billion Excel users worldwide, adding a new feature has to be thoroughly tested to ensure that there are no backward compatibility issues or breaking changes, and that takes a lot of time. Case in point: we had to wait almost three years until Excel 2016 to connect Power View reports to multidimensional cubes (only Tabular was supported before), although Analysis Services Multidimensional has much broader adoption than Tabular.

For consumers, rolling out a Microsoft BI solution has been problematic. Microsoft BI has been traditionally criticized for its deployment complexity and steep price tag. Although SharePoint Server offers much more than just data analytics, having a SharePoint server integrated with SQL Server has been a cost-prohibitive proposition for smaller organizations. As many of you would probably agree, SharePoint Server adds complexity and troubleshooting it isn't for the faint of heart. Power BI for Office 365 alleviated some of these concerns by shifting maintenance to become Microsoft's responsibility but many customers still find its "everything but the kitchen sink" approach too overwhelming and cost-prohibitive if all they want is the ability to deploy and share BI artifacts.

On the desktop, Excel wasn't originally designed as a BI tool, leaving the end user with the impression that BI was something Microsoft bolted on top of Excel. For example, navigating add-ins and learning how to navigate the cornucopia of features has been too much to ask from novice business users.

How does the new Power BI address these challenges?

Power BI embraces the following design tenets to address the previous pain points:

- Simplicity – Power BI was designed for BI from the ground up. As you'll see, Microsoft streamlined and simplified the user interface to ensure that your experience is intuitive and you aren't distracted by other non-BI features and menus.

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- No dependencies to SharePoint and Office – Because it doesn't depend on SharePoint and Excel, Power BI can evolve independently. This doesn't mean that business users are now asked to forgo Excel. To the contrary, if you like Excel and prefer to create data models in Excel, you'll find that you can still deploy them to Power BI.
- Frequent updates – Microsoft promises weekly updates for Power BI Service and monthly updates for Power BI Desktop. This should allow Microsoft to stay at the forefront of the BI market.
- Always up to date – Because of its service-based nature, as a Power BI subscriber you're always on the latest and greatest version.
- Free – As you'll see in "1.2.4 Power BI Editions and Pricing" (later in this chapter), Power BI has the best business model: most of it it's free! Power BI Desktop and Power BI Mobile are free. Power BI Service is free and has a Power BI Pro subscription option that you could pay for, following a freemium model. Cost was the biggest hindrance of Power BI, and it's now been turned around completely. You can't beat free!

1.1.4 Power BI and the Microsoft Data Platform

Power BI isn't the only BI product that Microsoft provides. It's an integral part of the Microsoft Data Platform that started in early 2004 with the powerful promise to bring "BI to the masses." Microsoft subsequently extended the message to "BI to the masses, by the masses" to emphasize its commitment to democratize. Indeed, a few years after Microsoft got into the BI space, the BI landscape changed dramatically. Once a domain of cost-prohibitive and highly specialized tools, BI is now within the reach of every user and organization!

Understanding the Microsoft Data Platform

Figure 1.4 illustrates the most prominent services of the Microsoft Data Platform (and there are new cloud services added almost every month!)

Figure 1.4 The Microsoft Data Platform provides services and tools that address various data analytics and management needs on premises and in the cloud.

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DEFINITION The Microsoft Data Platform is a multi-service offering that addresses the data capturing, transformation, and analytics needs to create modern BI solutions. It's powered by Microsoft SQL Server, SharePoint Server and Microsoft Office on premises and Microsoft Azure in the cloud.

Table 1.1 summarizes the various services of the Microsoft Data Platform and their purposes.

Table 1.1 The Microsoft Data Platform consists of many products and services, with the most prominent described below.

Category	Service	Audience	Purpose
Capture and manage	Relational	IT	Capture relational data in SQL Server, Analytics Platform System, Microsoft Access, and others.
	Non-relational	IT	Capture Big Data in Azure HDInsight Service and Microsoft HDInsight Server.
	NoSQL	IT	Capture NoSQL data in cloud structures, such as Azure Table Storage, DocumentDB, and others.
	Streaming	IT	Allow capturing of data streams from Internet of Things (IoT).
	Internal and External	IT/Business	Referring to cloud on your terms, allow connecting to both internal and external data, such as connecting Power BI to online services (Google Analytics, Salesforce, Dynamics CRM, and many others).
Transform and analyze	Orchestration	IT/Business	Create data orchestration workflows with SQL Server Integration Services (SSIS), Azure Data Factory, Power Query, Power BI Desktop, and Data Quality Services (DQS).
	Information management	IT/Business	Allow IT to establish rules for information management and data governance using SharePoint, Azure Data Catalog, and Office 365, as well as manage master data using SQL Server Master Data Services.
	Complex event processing	IT	Process data streams using SQL Server StreamInsight on premise and Azure Stream Analytics Service in the cloud.
	Modelling	IT/Business	Transform data in semantic structures with Analysis Services Multidimensional, Tabular, Power Pivot, and Power BI.
	Machine learning	IT/Business	Create data mining models in SQL Server Analysis Services, Excel data mining add-in, and Azure Machine Learning Service.
Visualize and decide	Applications	IT/Business	Analyze data with desktop applications, including Excel, Power BI Desktop, SSRS Designer, Report Builder, Datazen, Power View, Power Map.
	Reports	IT/Business	Create operational and ad hoc reports with SSRS, Excel, Datazen, and Power BI.
	Dashboards	IT/Business	Implement and share dashboards with Power BI, Excel, SharePoint, SSRS, and Datazen.
	Mobile	IT/Business	Support mobile devices

For more information about the Microsoft Data Platform, please visit https://www.microsoft.com/en-us/server-cloud/solutions/business-intelligence.

The role of Power BI in the Microsoft Data Platform

In Table 1.1, you can see that Power BI plays an important role in the Microsoft Data Platform by providing services for getting, transforming and visualizing your data. As far as data acquisition goes, it can connect to cloud and on-premises data sources so that you can import and relate data irrespective of its origin.

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Capturing data is one thing but making dirty data suitable for analysis is quite another. However, you can use the data transformation capabilities of Power BI Desktop or Excel Power Query to cleanse and enrich your data. For example, someone might give you an Excel crosstab report. If you import the data as it is, you'll quickly find that you won't be able to relate it to the other tables in your data model. However, with a few clicks, you can un-pivot your data and remove unwanted rows. Moreover, the transformation steps are recorded so that you can repeat the same transformations later if you're given an updated file.

The main purpose and strength of Power BI is visualizing data in reports and dashboards without requiring any special skills. You can explore and understand your data by having fun with it. To summarize insights from these reports, you can then compile a dashboard. Or, you can build the dashboard by asking natural questions. **Figure 1.5** shows a sample dashboard assembled from existing reports.

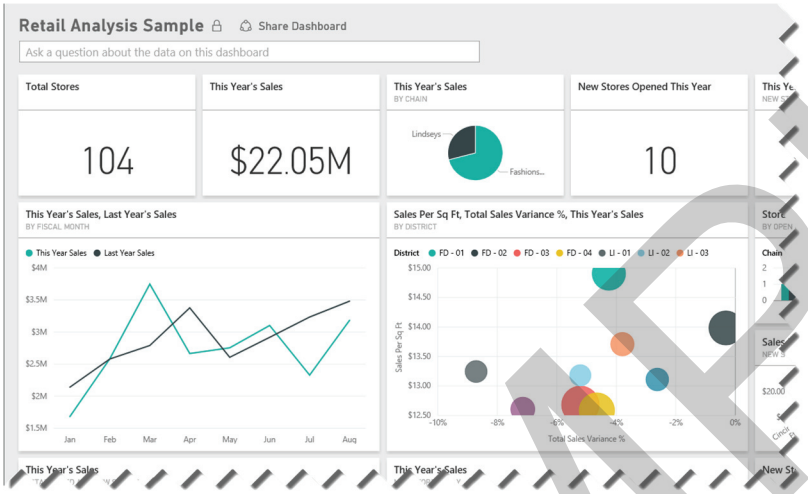

Figure 1.5 Power BI lets you assemble dashboards from existing reports or by asking natural questions.

1.2 Understanding the Power BI Products

Now that I've introduced you to Power BI and the Microsoft Data Platform, let's take a closer look at the Power BI building blocks. Don't worry if you don't immediately understand some of these technologies or if you find this section too technical. I'll clarify them throughout the rest of this chapter and the book. As I mentioned in section 1.1, Power BI is an umbrella name that unifies three products: Power BI Service, Power BI Mobile, and Power BI Desktop.

1.2.1 Understanding Power BI Service

At the heart of Power BI is the cloud-based business analytics service referred to *Power BI Service* or just *Power BI*. You use the service every time you utilize any of the powerbi.com features, such as connecting to online services, deploying and refreshing data models, viewing reports and dashboards, sharing content, or using Q&A (the natural language search feature). Next, I'll introduce you to some of Power BI Service's most prominent features.

Connect to any data source

The BI journey starts with connecting to data that could be a single file or multiple data sources. Power BI allows you to connect to virtually any accessible data source. Your self-service project can start small. If all you need is to analyze a single file, such as an Excel workbook, you might not need a data model. Instead, you can connect Power BI to your file, import its data, and start analyzing data immediately. However, if

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your data acquisition needs are more involved, such as when you have to relate data from multiple sources, you can use Power BI Desktop to implement a data model whose capabilities can be on par with professional data models and cubes!

Some data sources, such as Analysis Services models, support live connections. Because data isn't imported, live connections allow reports and dashboards to be always up to date. In the case when you have to import data, you can specify how often the data will be refreshed to keep it synchronized with changes in the original data source. For example, Martin might have decided to import data from the corporate data warehouse and deploy the model to Power BI. To keep the published model up to date, Martin can schedule the data model to refresh daily.

Content packs for online services

Continuing on data connectivity, chances are that your organization uses popular cloud services, such as Salesforce, Marketo, Dynamics CRM, Google Analytics, Zendesk, and others. Power BI content packs for online services allow business users to connect to such services and analyze their data without technical setup and data modeling. Content packs include a curated collection of dashboards and reports that continuously update with the latest data from these services. With a few clicks, you can connect to one of the supported online services and start analyzing data using prepackaged reports and dashboards. If the provided content isn't enough, you can create your own reports and dashboards. **Figure 1.6** shows a prepackaged dashboard I quickly implemented for analyzing website traffic with Google Analytics.

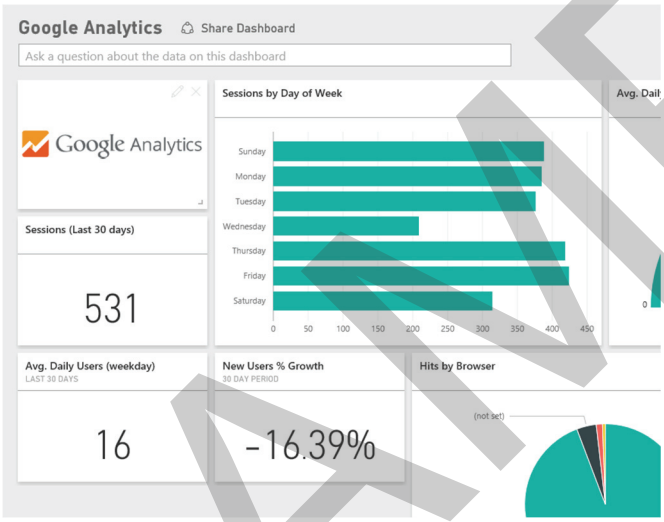

Figure 1.6 Content packs allow you to connect to online services and analyze data using prepackaged reports and dashboards.

Dashboards and reports

Collected data is meaningless without useful reports. Insightful dashboards and reports is what Power BI Service is all about. With a few clicks, a business user can create interactive reports. If you're familiar with Power View, you'll find that Power BI reports offer the same engaging experience for analyzing data by having fun with it!

For example, the report in **Figure 1.7** demonstrates one of these interactive features. In this case, the user selected Linda in the Bar Chart on the right. This action filtered the Column Chart on the left so that the user can see Linda's contribution to the overall sales.

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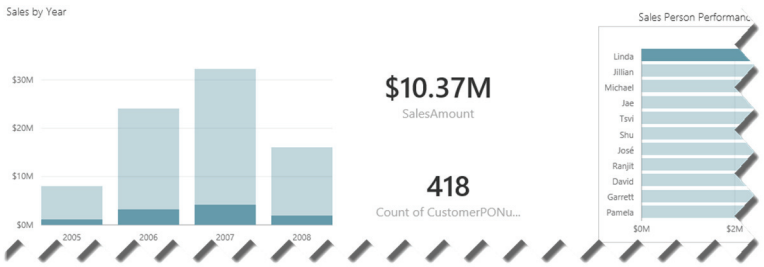

Figure 1.7 Interactive reports allow users to explore data in different ways.

Natural queries (Q&A)

Based on my experience, the feature that excites the users the most is Power BI natural queries or Q&A. End users are often overwhelmed when asked to create ad hoc reports from a data model. They don't know which fields to use and where to find them. The unfortunate "solution" by IT is to create new reports in an attempt to answer new questions. This might result in a ton of reports that quickly get replaced by new reports and are never used again. However, Power BI allows users to ask natural questions, such as "show sales amount by country in descending order by sales amount" (see **Figure 1.8**).

Figure 1.8 Q&A allows users to explore data by asking natural questions.

Not only can Power BI interpret natural questions, but it also chooses the best visualization! While in this case Q&A has decided to use a Bar Chart, it might have chosen a map if the question was phrased in a different way. And, the user can always change the visualization manually if the Power BI selection isn't adequate.

NOTE As of the time of writing this book, Q&A is supported only when data is imported into Power BI, such as when you get data from cloud services, Excel files, and Excel or Power BI Desktop data models. Q&A isn't currently supported with live connectivity, such as when you connect to on-premises Analysis Services data models. Q&A is also currently in English only.

Sharing and collaboration

Once you've created informative reports and dashboards, you might want to share them with your coworkers. Power BI supports several sharing options. Power BI Free allows you to share dashboards as read-only with your coworkers. Or you can use Power BI Pro workspaces to allow groups of people to

SAMPLE

have access to the same workspace content. For example, if Maya works in sales, she can create a Sales Department workspace and grant her coworkers access to the workspace. Then all content added to the Sales Department workspace will be shared among the group members.

Yet a third way to share content is to create an organizational content pack. Organizational content packs allow you to share content across teams or even or with everyone from your organization. Users can discover and open content packs from the Power BI Content Gallery (see **Figure 1.9**). In this case, the user sees that someone has published a Reseller Sales content pack. The user can click the pack to see who published it, when it was published, and what it contains. Then the user can connect to the pack and access its content.

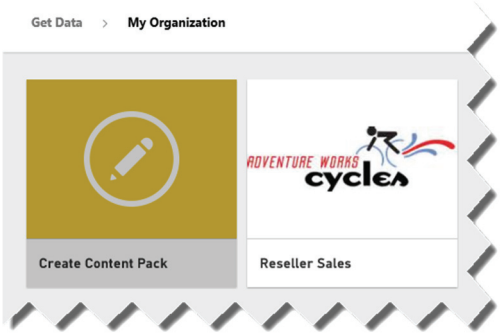

Figure 1.9 Users within your organization can use the Power BI Content Gallery to discover published organizational content packs.

1.2.2 Understanding the Power BI Service Architecture

The Power BI Service is hosted on Microsoft Azure cloud platform and it's currently deployed in 14 data centers. **Figure 1.10** shows a summarized view of the overall technical architecture that consists of two clusters: a Web Front End (WFE) cluster and a Back End cluster.

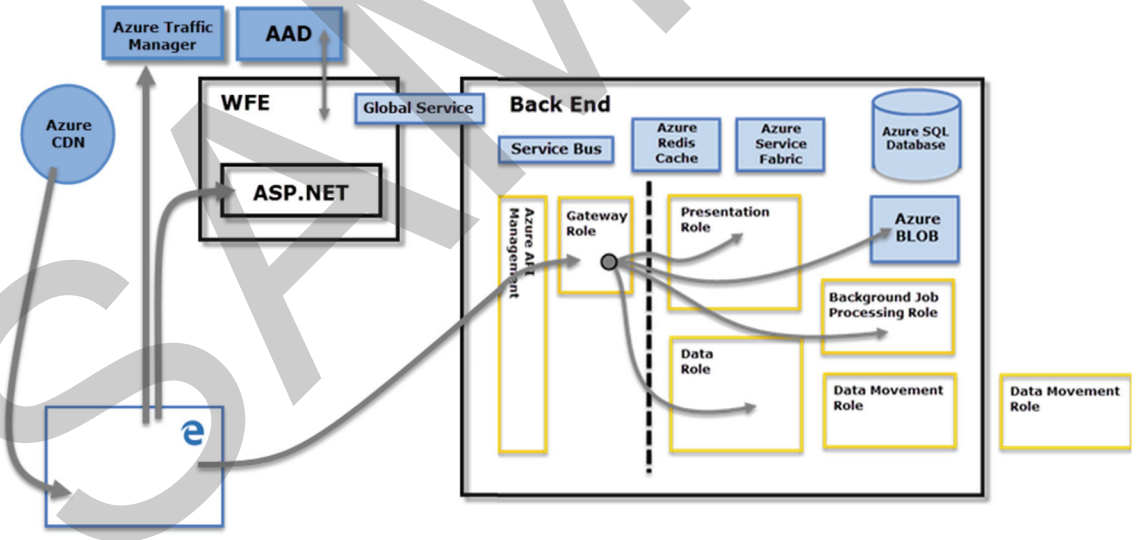

Figure 1.10 Power BI is powered by Microsoft Azure clusters.

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Understanding the Web Front End (WFE) cluster

Microsoft has put a significant effort into building a scalable backend infrastructure consisting of various Azure services that handle data storage, security, load balancing, disaster recovery, logging, tracing, and so on. Although it's all implemented and managed by Microsoft (that's why we like the cloud), the following sections give you a high-level overview of these services to help you understand their value and Microsoft's decision to make Power BI a cloud service.

The WFE cluster manages connectivity and authentication. Power BI relies on Azure Active Directory (AAD) to manage account authentication and management. Power BI uses the Azure Traffic Manager (ATM) to direct user traffic to the nearest datacenter. Which data center is used is determined by the DNS record of the client attempting to connect. The DNS Service can communicate with the Azure Traffic Manager to find the nearest datacenter with a Power BI deployment.

TIP To find where your data is stored, log in to Power BI and click the Help (?) menu in the top-right corner, and then click "About Power BI". Power BI shows a prompt that includes the Power BI version and the data center.

Power BI uses the Azure Content Delivery Network (CDN) to deliver the necessary static content and files to end users based on their geographical locale. The WFE cluster nearest to the user manages the user login and authentication, and provides an access token to the user once authentication is successful. The ASP.NET component within the WFE cluster parses the request to determine which organization the user belongs to, and then consults the Power BI Global Service.

The Global Service is implemented as a single Azure Table that is shared among all worldwide WFE and Back End clusters. This service maps users and customer organizations to the datacenter that host their Power BI tenant. The WFE specifies to the browser which Back End cluster houses the organization's tenant. Once a user is authenticated, subsequent client interactions occur with the Back End cluster directly and the WFE cluster is not used.

Understanding the Back End cluster

The Back End cluster manages all actions the user does in Power BI Service, including visualizations, dashboards, datasets, reports, data storage, data connections, data refresh, and others. The Gateway Role acts as a gateway between user requests and the Power BI service. As you can see in the diagram, only the Gateway Role and Azure API Management (APIM) services are accessible from the public Internet. When an authenticated user connects to the Power BI Service, the connection and any request by the client is accepted and managed by the Gateway Role, which then interacts on the user's behalf with the rest of the Power BI Service. For example, when a client attempts to view a dashboard, the Gateway Role accepts that request, and then then sends a request to the Presentation Role to retrieve the data needed by the browser to render the dashboard.

As far as data storage goes, Power BI uses two primary repositories for storing and managing data. Data that is uploaded from users is typically sent to Azure BLOB storage but all the metadata definitions (dashboards, reports, recent data sources, workspaces, organizational information, tenant information) are stored in Azure SQL Database.

The working horse of the Power BI service is Microsoft Analysis Services in Tabular mode, which has been architected to fulfill the role of a highly scalable data engine where many servers (nodes) participate in a multi-tenant, load-balanced farm. For example, when you import some data into Power BI, the actual data is stored in Azure BLOB storage but an in-memory Tabular database is created to service queries.

For BI pros who are familiar with Tabular, new components have been implemented so that Tabular is up to its new role. These components enable various cloud operations including tracing, logging, service-to-service operations, reporting loads and others. For example, Tabular has been enhanced to support the following features required by Power BI:

- Custom authentication – Because the traditional Windows NTLM authentication isn't appropriate in the cloud world, certificate-based authentication and custom security were added.

SAMPLE

- Resource governance per database – Because databases from different customers (tenants) are hosted on the same server, Tabular ensures that any one database doesn't use all the resources.
- Diskless mode – For performance reasons, the data files aren't initially extracted to disk.
- Faster commit operations – This feature is used to isolate databases from each other. When committing data, the server-level lock is now only taken for a fraction of time, although database-level commit locks are still taken and queries can still block commits and vice versa.
- Additional Dynamic Management Views (DMVs) – For better status discovery and load balancing.
- Data refresh – From the on-premises data using the Analysis Services connector.
- Additional features – Such as the new features added to Analysis Services in SQL Server 2016.

Data on your terms

The increasing number of security exploits in the recent years have made many organizations cautious about protecting their data and skeptical about the cloud. You might be curious to know what is uploaded to the Power BI service and how you can reduce your risk for unauthorized access to your data. In addition, you control where your data is stored. Although Power BI is a cloud service, this doesn't necessarily mean that your data must be uploaded to Power BI.

In a nutshell, you have two options to access your data. If the data source supports live connectivity, you can choose to leave the data where it is and only create reports and dashboards that connect live to your data. Currently, only a small subset of data sources supports live connectivity but that number is growing! Among them are Analysis Services, SQL Server (on premises and on Azure), Azure SQL Data Warehouse, and Hadoop Spark.

For example, if Elena has implemented an Analysis Services model and deployed to a server in her organization's data center, Maya can create reports and dashboards in Power BI Service by directly connecting to the model. In this case, the data remains on premises; only the report and dashboard definitions are hosted in Power BI. When Maya runs a report, the report generates a query and sends the query to the model. Then, the model returns the query results to Power BI. Finally, Power BI generates the report and sends the output to the user's web browser. Power BI always uses the Secure Sockets Layer (SSL) protocol to encrypt the traffic between the Internet browser and the Power BI Service so that sensitive data is protected.

NOTE Although in this case the data remains on premises, data summaries needed on reports and dashboards still travel from your data center to Power BI Service. This could be an issue for software vendors who have service level agreements prohibiting data movement. You can address such concerns by referring the customer to the Power BI Security document (http://bit.ly/1SkEzTP) and the accompanying Power BI Security whitepaper.

The second option is to upload and store the data in Power BI. For example, Martin might want to build a data model to analyze data from multiple data sources. Martin can use Power BI Desktop to import the data and analyze it locally. To share reports and allow other users to create reports, Martin decides to deploy the model to Power BI. In this case, the model and the imported data are uploaded to Power BI, where they're securely stored. To synchronize data changes, Martin can schedule a data refresh. Martin doesn't need to worry about security because data transfer between Power BI and on-premises data sources is secured through Azure Service Bus. Azure Service Bus creates a secure channel between Power BI Service and your computer. Because the secure connection happens over HTPS, there's no need to open a port in your company's firewall.

TIP If you want to avoid moving data to the cloud, one solution you can consider is implementing an Analysis Services model layered on top your data source. Not only does this approach keep the data local, but it also offers other important benefits, such as the ability to handle larger datasets (millions of rows), a single version of the truth by centralizing business calculations, row-level security, and others.

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1.2.3 Understanding Power BI Mobile

Power BI Mobile is a set of native mobile applications for iOS (iPad and iPhone), Windows and Android devices. You can access the download links from https://powerbi.microsoft.com/mobile. Why do you need these applications? After all, thanks to Power BI HTML5 rendering, you can view Power BI reports and dashboards in your favorite Internet browser. However, the native applications offer features that go beyond just rendering. Although there are some implementation differences, this section covers some of the most compelling features (chapter 4 has more details).

Favorites

Suppose that, while viewing dashboard tiles on your iPad, you want to put your favorite tiles in one place. You can just tap a tile to mark it as a favorite. These tiles appear in a separate "Favorites" folder. The dashboard tiles displayed on your device are live snapshots of your data. To interact with a tile, just tap it!

Alerts

Do you want to be notified when your data changes beyond certain levels? Of course you do! You can set rules to be alerted when single number tiles in your dashboard exceed limits that you set. With data-driven alerts, you can gain insights and take action wherever you're located.

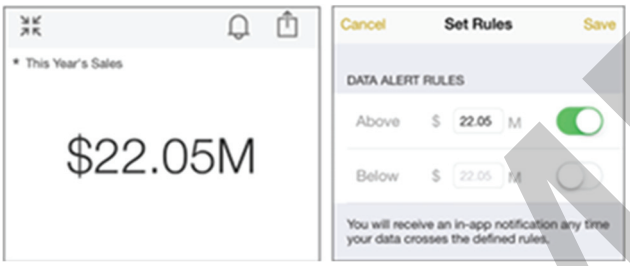

Figure 1.11 Power BI Mobile data alerts allow you to be notified when important data changes happen.

For example, **Figure 1.11** shows that I've enabled an iPhone data alert with a data rule above $22.05 million. When sales exceed this threshold, I'll get an in-app notification.

Annotations

Annotations allow you to add comments (lines, text, and stamps) to dashboard tiles (see **Figure 1.12**). Then you can mail a screen snapshot to recipients, such as to your manager.

Figure 1.12 Annotations allow you to add comments to tiles and then send screenshots to your coworkers.

Sharing

Similar to Power BI simple sharing, you can use mobile device to share a dashboard by inviting coworkers to access the dashboard. Dashboards shared by mail are read-only, meaning that the people you shared with can only view the dashboard without making changes.

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1.2.4 Understanding Power BI Desktop

Oftentimes, data analytics go beyond a single dataset. To meet more advanced needs, business analysts create data models, such as to relate data from multiple data sources and them implement business calculations. The Power BI premium design tool for implementing such models is Power BI Desktop.

Installing Power BI Desktop

Power BI Desktop is a freely available Windows application for implementing self-service data models and reports. You can download it for free from https://powerbi.microsoft.com/en-us/desktop or from the Downloads menu in Power BI Service. Power BI Desktop is available as 32-bit and 64-bit Windows installations. The download page determines what version of Windows you have (32-bit or 64-bit) and downloads the appropriate executable.

Nowadays, you can't buy a 32-bit computer (not easily, anyway). However, even if you have a 64-bit computer and 64-bit Windows OS, you can still install 32-bit applications. The problem is that 32-bit applications are limited to 2 GB of memory. By contrast, 64-bit computing enables applications to use more than 2 GB of memory. This is especially useful for in-memory databases that import data, such as xVelocity (remember that xVelocity is the storage engine of Power BI Service and Power BI Desktop). In general, if you have a 64-bit version of Windows, you should install the 64-bit version of any software if a 64-bit version is available. Therefore, the 64-bit version of Power BI Desktop is a better choice. However, although your model on the desktop can grow and grow until it exhausts all the memory, remember that Power BI Service won't let you upload a file that is larger than 250 MB (this limit will probably increase) so this keep in mind as well if you plan to publish the model.

NOTE Readers familiar with Excel data modeling might remember that the Office setup installs the 32-bit version of Office by default and getting IT to install the 64-bit version has been a struggle. The Office setup favors the 32-bit version in case you use 32-bit add-ins. Because Power BI Desktop doesn't depend on Office, you can go ahead and install the 64-bit version even if you have the 32-bit version of Office installed.

Understanding Power BI Desktop features

Before Power BI, data analysts could implement data models in Excel. This option is still available, and you can upload your Excel data models to Power BI. However, to overcome the challenges associated with Excel data modeling (see section 1.1.3), Microsoft introduced Power BI Desktop.

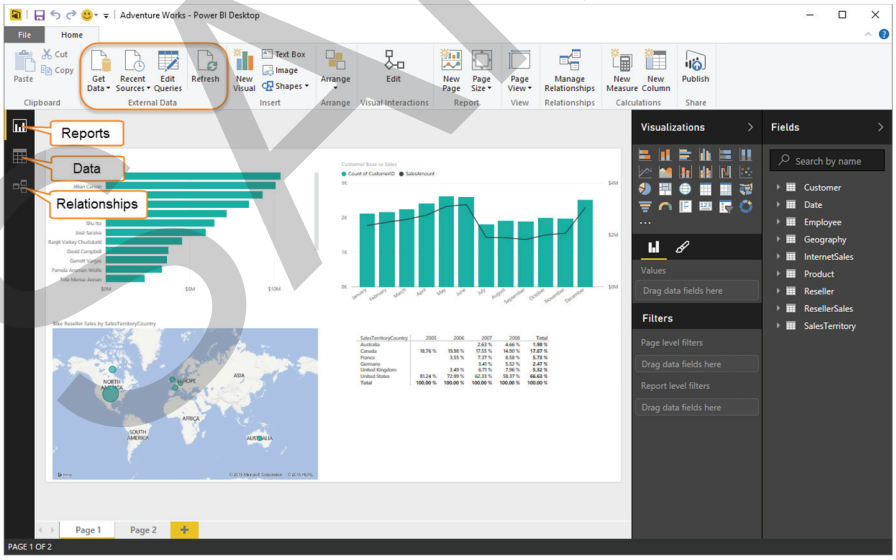

Figure 1.13 Power BI Desktop unifies the capabilities of Power Pivot, Power Query, and Power View.

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Think of Power BI Desktop as the unification of Power Pivot, Power Query, and Power View. Previously available as Excel add-ins, these tools now blend into a single flow. No more guessing which add-in to use and where to find it! At a high level, the data modelling experience in Power BI Desktop now encompasses the following steps (see **Figure 1.13**):

1. Former Power Query – Use the Get Data button in the ribbon to connect to and transform the data. This process is similar to using Excel Power Query. When you import a dataset, Power BI Desktop creates a table and loads the data. The data is stored in a highly compressed format and loaded in memory to allow you to slice and dice the data without sacrificing performance. However, unlike Excel, Power BI Desktop allows you to connect directly to a limited number of fast databases, such as Analysis Services and Azure SQL Data Warehouse, where it doesn't make sense to import the data.
2. Former Power Pivot – View and make changes to the data model using the Data and Relationships tabs in the left navigation bar. This is the former Power Pivot part.
3. Former Power View – Create interactive reports using the Reports tab on the left, as you can do using Power View in Excel (version 2013 or higher).

NOTE Some data sources, such as Analysis Services, support live connectivity. Once you connect to a live data source, you can jump directly to step 3 above and start creating reports because there are no queries to edit and models to design. In this case, Power BI Desktop acts as a presentation layer that's directly connected to the data source.

Comparing design environments

Because there are many Power Pivot models out there, Power BI allows data analysts to deploy Excel files with embedded data models to Power BI Service and view the included pivot reports and Power View reports online. Analysts can now choose which modeling tool to use:

- Microsoft Excel – Use this option if you prefer to work with Excel and you're familiar with the data modelling features delivered by Power Pivot, Power Query, Power View and Power Map.
- Power BI Desktop – Use this free option if you prefer a simplified tool that's specifically designed for data analytics and that's updated more frequently than Excel.

Table 1.2 compares these two design options side by side to help you choose a design environment.

Table 1.2 This table compares the data modelling capabilities of Microsoft Excel and Power BI Desktop.

Feature	Excel	Power BI Desktop
Data import	Excel native import, Power Pivot, Power Query	Query Editor
Data transformation	Power Query	Query Editor
Modeling	Power Pivot	Data and Relationships tabs
Reporting	Excel pivot reports, Power View, Power Map	Power View-based reports
Update frequency	Office releases or more often with Office 365 click-to-run	Monthly
Server deployment	SharePoint Server and Power BI	Power BI
Power BI deployment	Deployed as Excel (*.xlsx) file	Deployed as Power BI Desktop (pbix) file
Convert models	Can't import Power BI Desktop models	Can import Excel data model
Upgrade to Tabular	Yes	No
Cost	Excel license	Free

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Let's go quickly through the list. While Excel supports at least three ways to import data, many users might struggle in understanding how they compare. By contrast, Power BI Desktop has only one data import option which is the equivalent of Power Query in Excel. Similarly, Excel has various menus in different places that relate to data modelling. By contrast, if you use Power BI Desktop to import data, your data modelling experience is much more simplified.

Excel allows you to create pivot, Power View, and Power Map reports from data models. At this point, Power BI Desktop supports only the equivalent of Excel Power View reports and some of the Power Map features, although it regularly adds more visualizations and features.

The Excel update frequency depends on how it's installed. If you install it from a setup disk (MSI installation), you need to wait for the next version to get new features. Office 365 supports subscription-based Microsoft Office (click-to-run installation) which delivers new features as they get available. If you take the Power BI Desktop path, you'll need to download and install updates as they become available. Microsoft announced that Power BI Desktop will get monthly updates so you'll get new features faster.

As far as deployment goes, you can deploy Excel files with data models to Power BI, just like you can deploy them to SharePoint Server or Office 365. Power BI Desktop models (files with extension *.pbix) can be deployed to Power BI only. Behind the scenes, both Excel and Power BI Desktop use the in-memory xVelocity engine to compress and store imported data.

NOTE At the PASS Summit in October 2015, Microsoft announced that a future SQL Server Reporting Services edition (past SQL Server 2016) will support Power BI Desktop files. Currently, only Power BI Service supports online rendering of Power BI Desktop models.

As of the time of writing, Power BI Desktop supports importing Power Pivot models from Excel to allow you to migrate models from Excel to Power BI Desktop. Excel doesn't support importing Power BI Desktop models yet so you can't convert your Power BI Desktop files to Excel data models. A BI pro can migrate Excel data models to Tabular models when organizational features, such as scalability and security, are desirable. Currently, Tabular can't import Power BI Desktop models because Power BI adds features constantly, which could put it ahead of the Tabular box features.

1.2.5 Power BI Editions and Pricing

Power BI editions and pricing is simple and well documented at https://powerbi.microsoft.com/pricing. This page also includes a table showing which features are available by which edition. As it stands, Power BI is available in two editions: Power BI (Free) and Power BI Pro.

NOTE These editions apply to Power BI Service (powerbi.com) only. Power BI Desktop and Power BI Mobile are freely available and they don't require a Power BI Service subscription.

Understanding the Power BI Free edition

The Power BI edition is a free offering but it has the following limitations:

- Data capacity – If you import data, you are limited to one GB of data storage.
- Data refresh – If you connect to online services, such as Google Analytics or Salesforce, you can't refresh data more frequently than daily.
- Data streaming – If Power BI connects to Azure Stream Analytics (http://azure.microsoft.com/en-us/services/stream-analytics) for real-time dashboards, streaming is capped at 10,000 rows per hour.
- Data connectivity – You can't refresh data from on-premises data sources. Let's say you've imported data from a corporate data warehouse into Power BI Desktop and deployed the model to Power BI. While you can analyze the imported data, this limitation prevents you from scheduling an automated

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refresh schedule to update the model. The free edition also doesn't include connecting to data sources that support live connections, such as Analysis Services, Spark on Azure HDInsight, Azure SQL Data Warehouse, and SQL Server.

- Content sharing and collaboration – Only simple sharing by mail is supported.

Despite these limitations, the free edition is packed with features. For example, Power BI Free will be appealing to a business user who's interested in Power BI content packs to analyze online data. This edition would allow a data analyst to create and publish sophisticated data models, refresh imported data, and share dashboards with a limited number of people.

Understanding the Power BI Pro edition

This paid edition currently charges currently $9.99 per user per month and offers the following extra features:

- Data capacity – It increases the data storage quota to 10 GB per user.
- Data refresh – It supports hourly data refreshes.
- Data streaming – It supports streaming to one million rows per second.
- Data connectivity – No data connectivity limitations.
- Content sharing and collaboration – Besides simple sharing, Power BI Pro also supports workspaces and organizational content packs.

Currently, Microsoft treats Power BI for Office 365 user licenses the same as Power BI Pro. So any user who has a Power BI for Office 365 business plan and signs up for Power BI Service, will automatically get a Power BI Pro license. If this isn't the desired outcome, the Office 365 administrator can use the Office 365 portal to remove the Power BI license from that user. Then the user will be downgraded to the free Power BI edition. This is explained in more detail in the "Power BI Transition" document at http://www.microsoft.com/en-us/powerBI/licensing.aspx.

NOTE Not sure if the Power BI Pro edition is right for you? You can evaluate it for free for 60 days. To start the trial period, log in the Power BI portal, click the Settings menu in the top right corner, and then click "Manage Personal Storage". Then click the "Try Pro for free" link.

1.3 Power BI and You

Now that I've introduced you to Power BI and its building blocks, let's see what Power BI means for you. As you'll see, Power BI has plenty to offer to anyone interested in data analytics, irrespective of whether you're a content producer or consumer, as shown in **Figure 1.14**.

By the way, the book content follows the same organization so that you can quickly find the relevant information depending on what type of user you are. For example, if you're a business user, the first part of the book is for you and it has three chapters for the first three features shown in the "For business users" section in the diagram.

1.3.1 Power BI for Business Users

To clarify the term, a business user is someone in your organization who is mostly interested in consuming BI artifacts, such as reports and dashboards. This group of users typically includes executives, managers, business strategists, and regular information works. To get better and faster insights, some business users often become basic content producers, such as when they create reports to analyze simple datasets or data from online services.

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Figure 1.14 Power BI supports the BI needs of business users, analysts, pros, and developers.

For example, Maya is a manager in the Adventure Works Sales & Marketing department. She doesn't have skills to create sophisticated data models and business calculations. However, she's interested in monitoring the Adventure Works sales by using reports and dashboards produced by other users. She's also a BI content producer because she has to create reports for analyzing data in Excel spreadsheets, website traffic, and customer relationship management (CRM) data.

Connect to your data without creating models

Thanks to the Power BI content packs, Maya can connect to popular cloud services, such as Google Analytics and Dynamics CRM, and get instant dashboards. She can also benefit from prepackaged datasets, reports, and dashboards, created jointly by Software as a Service (SaaS) partners and Microsoft.

For example, the Dynamics CRM connector provides an easy access to analyze data from the cloud-hosted version of Dynamics CRM. This connector uses the Dynamics CRM OData feed to auto-create a descriptive model that contains the most important entities, such as Accounts, Activities, Opportunities, Products, Leads, and others. Pre-built dashboards and reports, such as the one shown in **Figure 1.15**, provide immediate insights and can be further customized.

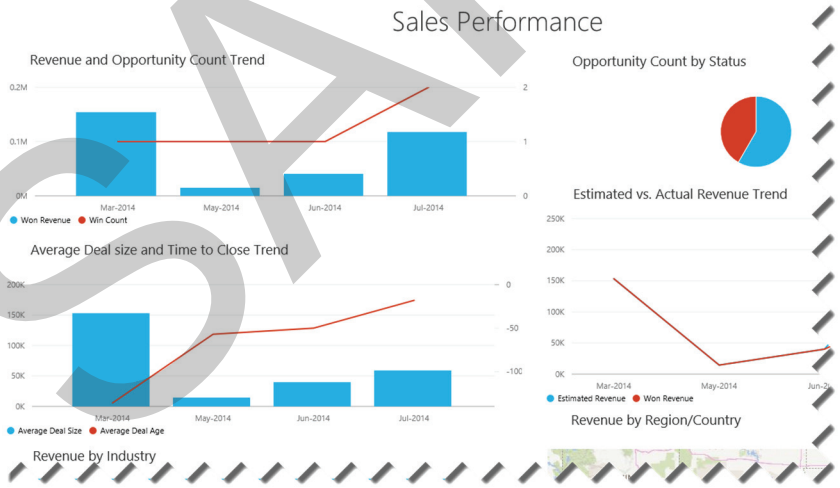

Figure 1.15 The Dynamics CRM content pack includes prepackaged reports and dashboards.

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Similarly, if Adventure Works uses Salesforce as a CRM tool, Power BI has a connector to allow Maya to connect to Salesforce in a minute. Power BI content packs support data refresh, such as to allow Maya to refresh the CRM data daily.

Explore data

Power BI can also help Maya analyze simple datasets without data modeling. For example, if Maya receives an Excel file with some sales data, she can import the data into Power BI and create ad hoc reports and dashboards with a few mouse clicks. She can easily share dashboards with coworkers. For example, Maya can navigate to the Power BI portal, select a dashboard, and then click the Share button next to the dashboard name (see **Figure 1.16**).

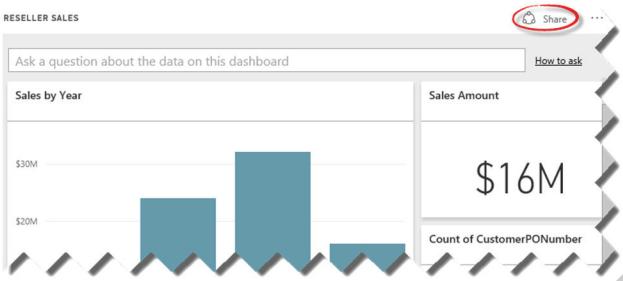

Figure 1.16 Business users can easily share dashboards with coworkers using the Power BI portal or Power BI Mobile.

Mobile applications

Some business users, especially managers, executives, and sales people, would need access to BI reports on the go. This type of users would benefit from the Power BI Mobile native applications for iPad, iPhone, Android, and Windows. As I explained in section 1.2.2, Power BI Mobile allows users to not only to view Power BI reports and dashboards, but to also receive alerts about important data changes, as well to share and annotate dashboards.

For example, while Maya travels on business trips, she needs access to her reports and dashboards. Thanks to the cloud-based nature of Power BI, she can access them anywhere she has an Internet connection. Depending on what type of mobile device she uses, she can also install a Power BI native application so she can benefit from additional useful features, such as favorites, annotations, and content sharing.

1.3.2 Power BI for Data Analysts

A data analyst or BI analyst is a power user who has the skills and desire to create self-service data models. A data analyst typically prefers to work directly with the raw data, such as to relate corporate sales data coming from the corporate data warehouse with external data, such as economic data, demographics data, weather data, or any other data purchased from a third party provider.

For example, Martin is a BI analyst with Adventure Works. Martin has experience in analyzing data with Excel and Microsoft Access. To offload effort from IT, Martin wants to create his own data model by combining data from multiple data sources.

Import and mash up data from virtually everywhere

As I mentioned previously, to create data models, Martin can use Microsoft Excel and/or Power BI Desktop, which combines the best of Power Query, Power Pivot and Power View in a single and simplified design environment. If he has prior Power Pivot experience, Martin will find Power BI Desktop easier to use and he might decide to switch to it in order stay on top of the latest Power BI features. Irrespective of the design environment chosen, Martin can use either Excel or Power BI Desktop to connect to any accessible data source, such as a relational database, file, cloud-based services, SharePoint lists, Exchange servers, and many more.

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Figure 1.17 shows the supported data sources in Power BI Desktop and Excel. Microsoft regularly adds new data sources and content packs. Once Martin deploys the model to Power BI, he can schedule a data refresh to keep the imported data up to date.

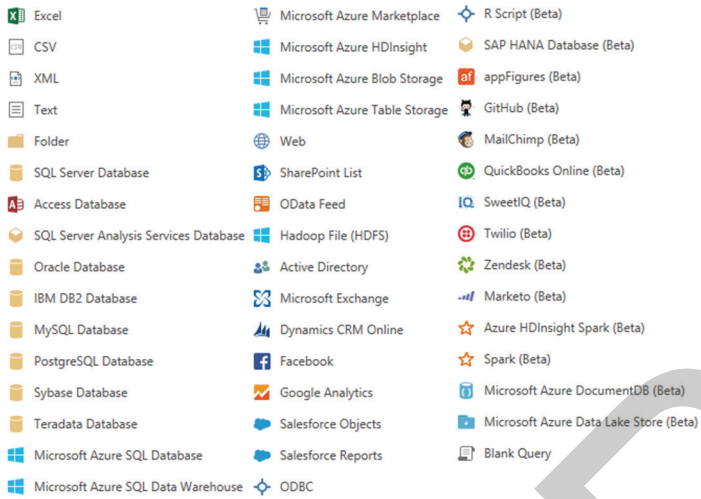

Figure 1.17 Power BI self-service data models can connect to a plethora of data sources.

Cleanse, transform, and shape data

Data is rarely cleaned. A unique feature of Power BI Desktop is cleansing and transforming data. Inheriting these features from Power Query, Power BI Desktop allows a data analyst to apply popular transformation tasks that saves tremendous data cleansing effort, such as replacing values, un-pivoting data, combining datasets and columns, and many more tasks.

For example, Martin may need to import an Excel financial report that was given to him in a crosstab format where data is pivoted by months on columns. Martin realizes that if he imports the data as it is, he won't be able to relate it to a date table that he has in the model. However, with a couple of mouse clicks, Martin can use a Power BI Desktop query to un-pivot months from columns to rows. And once Martin gets a new file, the query will apply the same transformations so that Martin doesn't have to go through the steps again.

Implement self-service data models

Once the data is imported, Martin can relate the datasets to analyze the data from different angles by relating multiple datasets (see **Figure 1.1** again). No matter which source the data came from, Martin can use Power BI Desktop or Excel to relate tables and create data models whose features are on par with professional models. Power BI supports relationships natively with one-to-many and many-to-many cardinality so Martin can model complex requirements, such as analyzing financial balances of joint bank accounts.

Create business calculations

Martin can also implement sophisticated business calculations, such as time calculations, weighted averages, variances, period growth, and so on. To do so, Martin will use the Data Analysis Expression (DAX) language and Excel-like formulas, such as the formula shown in **Figure 1.18**. This formula calculates the year-to-date (YTD) sales amount. As you can see, Power BI Desktop supports IntelliSense and color coding to help you with the formula syntax. IntelliSense offers suggestions as you type.

SAMPLE

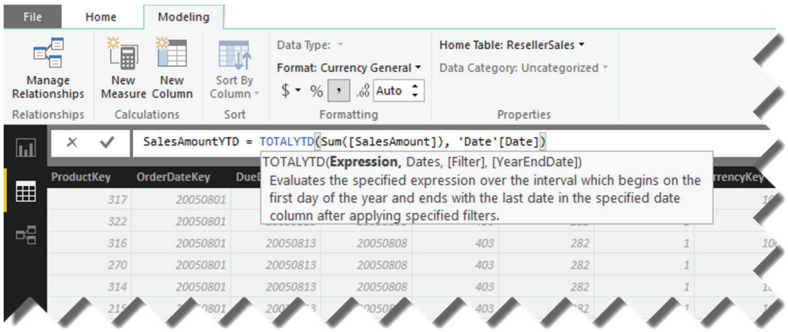

Figure 1.18 Business calculations are implemented in DAX.

Once the model is created, the analyst can visualize and explore the data with interactive reports. If you come from using Excel Power Pivot and would like to give Power BI Desktop a try, you'll find that not only does it simplify the design experience, but it also supports new visualizations, including Funnel and Combo Charts, Treemap, Filled Map, and Gauge visualizations, as shown in **Figure 1.19**.

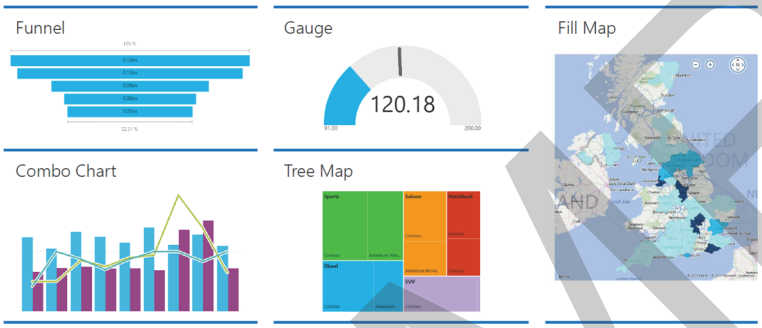

Figure 1.19 Power BI Desktop adds new visualizations.

And when the Microsoft-provided visualizations aren't enough, Martin can download a custom visual contributed by Microsoft and the Power BI community. To do this, Martin will go to the Power BI visuals gallery (http://visuals.powerbi.com) and download a visual file with the *.pbiviz file extension. Then, Martin can import the visual into Power BI Service or Power BI Desktop and start using it immediately!

Once Martin is done with the report in Power BI Desktop, he can publish the model and reports to Power BI, so that he can share insights with other users. If they have permissions, his coworkers can view reports, gain more insights with natural query (Q&A) questions, and create dashboards.

1.3.3 Power BI for Pros

BI pros and IT pros have much to gain from Power BI. BI pros are typically tasked to create the backend infrastructure required to support organizational BI initiatives, such as data marts, data warehouses, cubes, ETL packages, operational reports, and dashboards. IT pros are also concerned with setting up and maintaining the necessary environment that facilitates self-service and organizational BI, such as providing access to data, managing security, data governance, and other services.

In a department or smaller organization, a single person typically fulfills both BI and IT pro tasks. For example, Elena has developed an Analysis Services model on top of the corporate data warehouse. She needs to ensure that business users can gain insights from the model without compromising security.

SAMPLE

Enable team BI

Once she provided connectivity to the on-premises model, Elena must establish a trustworthy environment needed to facilitate content sharing and collaboration. To do so, she can use Power BI workspaces (a Power BI Pro feature). As a first step, Elena would set up groups and add members to these groups. Then Elena can create workspaces for the organizational units interested in analyzing the SSAS model. For example, if the Sales department needs access to the organizational model, Elena can set up a Sales Department group. Next, she can create a Sales Department workspace and grant the group access to it. Finally, she can deploy to the workspace her sales-related dashboards and reports that connect to the model.

If Elena needs to distribute BI artifacts to a wider audience, such as the entire organization, she can create an organizational content pack and publish it to the Power BI Content Gallery. Then her coworkers can search, discover, and use the content pack. Furthermore, they can create their own copies of the original dashboard and reports so that they can make changes without affecting the original copy.

Implementing BI solutions

Based on my experience, most organizations could benefit from what I refer to as a classic BI architecture that includes a data warehouse and semantic model (Analysis Service Multidimensional or Tabular mode) layered on top of the data warehouse. I'll discuss the benefits of this architecture in Part 3 of this book. If you already have or are planning such a solution, you can use Power BI as a presentation layer. This works because Power BI can connect to the on-premises Analysis Services, as shown in **Figure 1.20**.

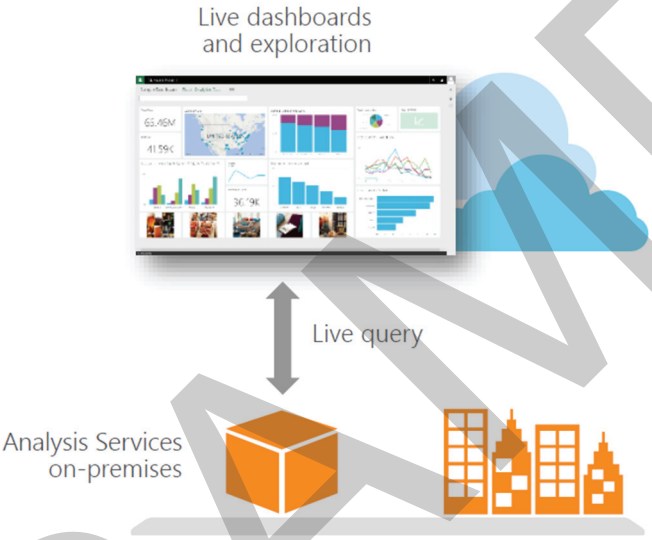

Figure 1.20 Power BI can directly connect to on-premises Analysis Services models.

So that Power BI can connect to on-premises SSAS models, Elena needs to download and install a component called Analysis Services Connector to an on-premises computer that can connect to the model. Elena can also set up the Power BI Enterprise Gateway to centralize management and access to on-premises data sources. Then Elena can implement reports and dashboards that connect live to Analysis Services and deploy them to Power BI. When users open a report, the report will generate a query and send it to the on-premises model via the Analysis Services connector. Now you have a hybrid solution where data stays on premises but reports are hosted in Power BI.

If you're concerned about the performance of this architecture, you should know that Power BI only sends queries to Analysis Services so there isn't much overhead on the trip from Power BI to SSAS. Typically, BI reports and dashboards summarize data. Therefore, the size of the datasets that travel back from SSAS to Power BI probably won't be very large either. Of course, the speed of the connection between Power BI and the data center where the model resides will affect the duration of the round trip.

SAMPLE

Another increasingly popular scenario that Power BI enables is real-time BI. You've probably heard about Internet of Things (IoT) which refers to an environment of many connected devices, such as barcode readers, sensors, or cell phones, that transfer data over a network without requiring human-to-human or human-to-computer interaction. If your organization is looking for a real-time platform, you should evaluate Microsoft Azure Stream Analytics. Microsoft Azure Stream Analytics allows you to monitor event streams in real time and push results to a Power BI dashboard.

Finally, BI pros can implement predictive data analytics solutions that integrate with Power BI. For example, Elena can use the Azure Machine Learning Service to implement a data mining model that predicts the customer probability to purchase a product. Then she can easily set up a REST API web service, which Power BI can integrate with to display results.

If all these BI pro features sound interesting, I'll walk you through these scenarios in detail in Part 3 of this book.

1.3.4 Power BI for Developers

Power BI has plenty to offer to developers as well because it's built on an open and extensible architecture. In the context of data analytics, developers are primarily interested in incorporating BI features in their applications or in providing access to data to support integration scenarios. For example, Teo is a developer with Adventure Works. Teo might be interested in embedding Power BI dashboards and reports in a web application that will be used by external customers. Power BI supports several extensibility options, including content packs, real-time reporting, custom visuals, and embedded reporting.

Real-time content and management

Power BI has a set of REST APIs to allow developers to programmatically manage certain Power BI resources, such as enumerating datasets, creating new datasets, and adding and removing rows to a dataset table. This allows developers to push data to Power BI, such as to create real-time dashboards. In fact, this is how Azure Stream Analytics integrates with Power BI. When new data is streamed, Azure Data Analytics pushes the data to Power BI to update real-time dashboards.

The process for creating such applications is straightforward. First you need to register your application with Microsoft Azure. Then you write OAuth2 security code to authenticate your application with Power BI. Then you'd write code to manipulate the Power BI objects using REST APIs. For example, here's a sample method invocation for adding one row to a table:

```
POST https://api.powerbi.com/beta/myorg/datasets/2C0CCF12-A369-4985-A643-0995C249D5B9/Tables/Product/Rows HTTP/1.1
Authorization: Bearer {AAD Token}
Content-Type: application/json
{
    "rows":
    [
        {
            "ProductID":1,
            "Name":"Adjustable Race",
            "Category":"Components",
            "IsCompete":true,
            "ManufacturedOn":"07/30/2014"
        }
    ]
}
```

Microsoft supports a Power BI Developer Center website (https://powerbi.microsoft.com/developers) where you can read the REST API documentation and try the REST APIs.

SAMPLE

Embed reports in custom applications

Many of you would like to embed beautiful Power BI dashboards and reports in custom web applications. For example, your company might have a web portal to allow external customers to log in and access reports and dashboards. Up until Power BI, Microsoft hasn't had a good solution to support this scenario. True, Microsoft provides an ASP.NET ReportViewer control in Visual Studio to let developers embed SSRS reports on custom ASP.NET pages but SSRS reports lack interactive features.

The good news is that Power BI has REST APIs to let developers embed dashboard tiles and reports. For example, Teo codes a customer-facing web application and he needs to allow end users to view Power BI content. Teo can integrate the web app with the Power BI REST APIs and embed Power BI reports. When the user logs in and navigates to a report, the user can see the report inside the application without having to navigate to Power BI Service. And, because embedded reports preserve interactive features, users can enjoy the same engaging experience, including report filtering, interactive sorting and highlighting.

Implement custom visuals

Microsoft has published the required interfaces to allow developers to implement and publish custom visuals using any of the JavaScript-based visualization frameworks, such as D3.js, WebGL, Canvas, or SVG. Do you need visualizations that Power BI doesn't support to display data more effectively? With some coding wizardry, you can implement your own!

Moreover, to speed up development Microsoft has published the code of all of the existing Power BI visualizations to GitHub (https://github.com/Microsoft/PowerBI-Visuals). Once you follow the instructions to install the Power BI Visuals Sample, you can see the source code (visuals are coded in TypeScript) and then create and test new visuals. When the custom visual is ready, you can publish it to the Power BI visuals gallery at https://visuals.powerbi.com where Power BI users can search for it and download it.

Implement content packs

I've already discussed how Power BI content packs can help you connect to popular online data sources, such as Dynamics CRM or Google Analytics. If you work for an independent software vendor (ISV) or System Integrator (SI), you can implement new content packs to facilitate access to data and to provide prepackaged content. You can contact Microsoft at http://solutions.powerbi.com/appsuggestion.html and sign up for the Microsoft partner program which coordinates this initiative.

As part of implementing a content pack, you'd need to create a connector using REST, OData, ODBC or other APIs to allow Power BI to connect to your data source and retrieve data. Your content pack can also include custom data models, reports, and dashboards.

1.4 Summary

This chapter has been a whirlwind tour of the innovative Power BI cloud data analytics service and its features. By now, you should view Power BI as a flexible platform that meets a variety of BI requirements. An important part of the Microsoft Data Platform, Power BI is a collective name of three products: Power BI Service, Power BI Mobile, and Power BI Desktop. You've learned about the major reasons that led to the release of Power BI. You've also taken a close look at the Power BI architecture and its components, as well as its editions and pricing model.

Next, this chapter discussed how Power BI can help different types of users with their data analytics needs. It allows business users to connect to their data and gain quick insights. It empowers BI analysts to create sophisticated data models. It enables IT and BI pros to implement hybrid solutions that span on-premises data models and reports deployed to the cloud. Finally, its extensible and open architecture let developers enhance the Power BI data capabilities and integrate Power BI with custom applications.

Having laid the foundation of Power BI, you're ready to continue the journey. Next, you'll witness the value that Power BI can deliver to business users.

SAMPLE