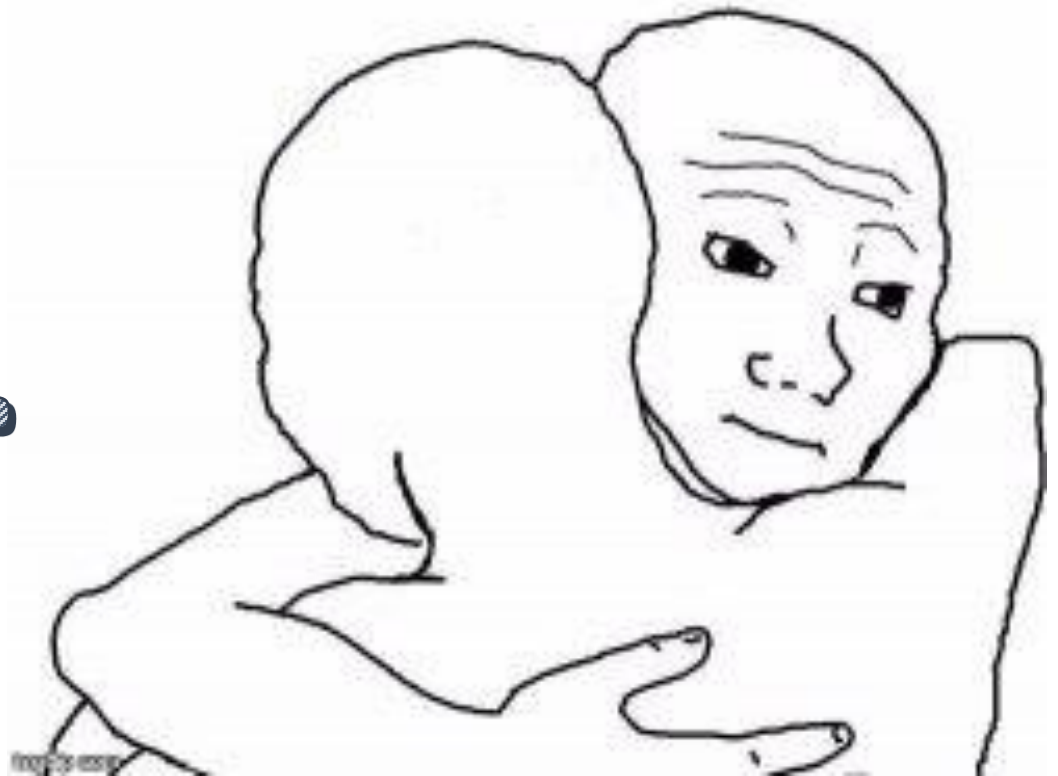


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# Describe core solutions and management tools on Azure

IS 306 – Cloud Computing



# Learning objectives

After completing this module, you'll be able to:

- Choose the Azure IoT service that best addresses your business scenario.
- Identify the business problems that Azure Synapse Analytics addresses.
- Describe core capabilities of Azure Synapse Analytics.
- Determine when to use Azure Synapse Analytics.



# Identify the product options

IoT enables devices to gather and then relay information for data analysis. Smart devices are equipped with sensors that collect data. A few common sensors that measure attributes of the physical world include:

- Environmental sensors that capture temperature and humidity levels.
- Barcode, QR code, or optical character recognition (OCR) scanners.
- Geo-location and proximity sensors.
- Light, color, and infrared sensors.
- Sound and ultrasonic sensors.
- Motion and touch sensors.
- Accelerometer and tilt sensors.
- Smoke, gas, and alcohol sensors.
- Error sensors to detect when there's a problem with the device.
- Mechanical sensors that detect anomalies or deformations.
- Flow, level, and pressure sensors for measuring gasses and liquids.



# IoT

<https://www.microsoft.com/en-us/videoplayer/embed/RWJvRn?postJsllMsg=true>



# Azure IoT services

By using Azure IoT services, devices that are equipped with these kinds of sensors and that can connect to the internet could send their sensor readings to a specific endpoint in Azure via a message. The message's data is then collected and aggregated, and it can be converted into reports and alerts. Alternately, all devices could be updated with new firmware to fix issues or add new functionality by sending software updates from Azure IoT services to each device.

Let's suppose your company manufactures and operates smart refrigerated vending machines. What kinds of information would you want to monitor? You might want to ensure that:

- Each machine is operating without any errors.
- The machines haven't been compromised.
- The machines' refrigeration systems are keeping their contents within a certain temperature range.
- You're notified when products reach a certain inventory level so you can restock the machines.



If the hardware of your vending machines can collect and send this information in a standard message, the messages each machine sends can be received, stored, organized, and displayed by using Azure IoT services.

The data that's collected from these devices could be combined with Azure AI services to help you predict:

- When machines need proactive maintenance.
- When inventories will need to be replenished and new product ordered from vendors.



Many services can assist and drive end-to-end solutions for IoT on Azure.

<https://www.microsoft.com/en-us/videoplayer/embed/RWGd57?postJsllMsg=true>





# Azure IoT Hub

Azure IoT Hub [↗](#) is a managed service that's hosted in the cloud and that acts as a central message hub for bi-directional communication between your IoT application and the devices it manages. You can use Azure IoT Hub to build IoT solutions with reliable and secure communications between millions of IoT devices and a cloud-hosted solution back end. You can connect virtually any device to your IoT hub.

The IoT Hub service supports communications both from the device to the cloud and from the cloud to the device. It also supports multiple messaging patterns, such as device-to-cloud telemetry, file upload from devices, and request-reply methods to control your devices from the cloud. After an IoT hub receives messages from a device, it can route that message to other Azure services.

From a cloud-to-device perspective, IoT Hub allows for *command and control*. That is, you can have either manual or automated remote control of connected devices, so you can instruct the device to open valves, set target temperatures, restart stuck devices, and so on.

IoT Hub monitoring helps you maintain the health of your solution by tracking events such as device creation, device failures, and device connections.




# Azure IoT Central




Azure IoT Central [↗](#) builds on top of IoT Hub by adding a dashboard that allows you to connect, monitor, and manage your IoT devices. The visual user interface (UI) makes it easy to quickly connect new devices and watch as they begin sending telemetry or error messages. You can watch the overall performance across all devices in aggregate, and you can set up alerts that send notifications when a specific device needs maintenance. Finally, you can push firmware updates to the device.


To help you get up and running quickly, IoT Central provides starter templates for common scenarios across various industries, such as retail, energy, healthcare, and government. You then customize the design starter templates directly in the UI by choosing from existing themes or creating your own custom theme, setting the logo, and so on. With IoT Central, you can tailor the starter templates for the specific data that's sent from your devices, the reports you want to see, and the alerts you want to send.



# Azure IoT Central

 Azure IoT Central




  
Home  
**Build**  
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## Build your IoT application


Test drive with a 7 day trial (limited to one per account), or build your own app that scales and grows with you.


### Featured


  
Custom app

Retail Energy Government Healthcare

  
Preview  
**Connected logistics**  
Track your shipment in real-time across air, water and land with location and condition monitoring.  
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**Digital distribution center**  
Improve warehouse output efficiency by digitalizing key assets and actions.  
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Digitally connect locations, create personalized customer experiences, and reduce operating costs.  
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Preview  
**Smart inventory management**  
Use sensors to automate receiving, product movement, cycle counting, and tracking.  
[Create app](#)  
[Learn more](#)



# Azure IoT Central

You can use the UI to control your devices remotely. This feature allows you to push a software update or modify a property of the device. You can adjust the desired temperature for one or all of your refrigerated vending machines from directly inside of IoT Central.

A key part of IoT Central is the use of device templates. By using a device template, you can connect a device without any service-side coding. IoT Central uses the templates to construct the dashboards, alerts, and so on. Device developers still need to create code to run on the devices, and that code must match the device template specification.

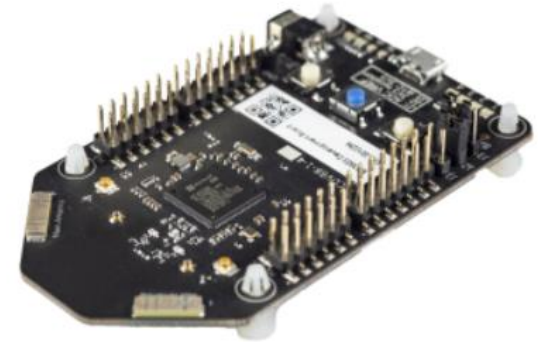


# Azure Sphere

Azure Sphere [↗](#) creates an end-to-end, highly secure IoT solution for customers that encompasses everything from the hardware and operating system on the device to the secure method of sending messages from the device to the message hub. Azure Sphere has built-in communication and security features for internet-connected devices.

Azure Sphere comes in three parts:

- The first part is the Azure Sphere micro-controller unit (MCU), which is responsible for processing the operating system and signals from attached sensors. The following image displays the Seeed Azure Sphere MT3620 Development Kit MCU, one of several different starter kits that are available for prototyping and developing Azure Sphere applications.
- The second part is a customized Linux operating system (OS) that handles communication with the security service and can run the vendor's software.
- The third part is Azure Sphere Security Service, also known as AS3. Its job is to make sure that the device has not been maliciously compromised. When the device attempts to connect to Azure, it first must authenticate itself, per device, which it does by using certificate-based authentication. If it authenticates successfully, AS3 checks to ensure that the device hasn't been tampered with. After it has established a secure channel of communication, AS3 pushes any OS or approved customer-developed software updates to the device.



After the Azure Sphere system has validated the authenticity of the device and authenticated it, the device can interact with other Azure IoT services by sending telemetry and error information.



# Is it critical to ensure that the device is not compromised?

Not in every case. Manufacturers and customers would rather not have their devices to be maliciously compromised and used for nefarious purposes, however in some cases it's more critical to ensure the integrity than others. An example would be that of an ATM in comparison to a washing machine. When security is a critical consideration in your product's design, the best product option is Azure Sphere, which provides a comprehensive end-to-end solution for IoT devices.

As we mentioned in the previous unit, Azure Sphere ensures a secure channel of communication between the device and Azure by controlling everything from the hardware to the operating system and the authentication process. This ensures that the integrity of the device is uncompromised. After a secure channel is established, messages can be received from the device securely, and messages or software updates can be sent to the device remotely.





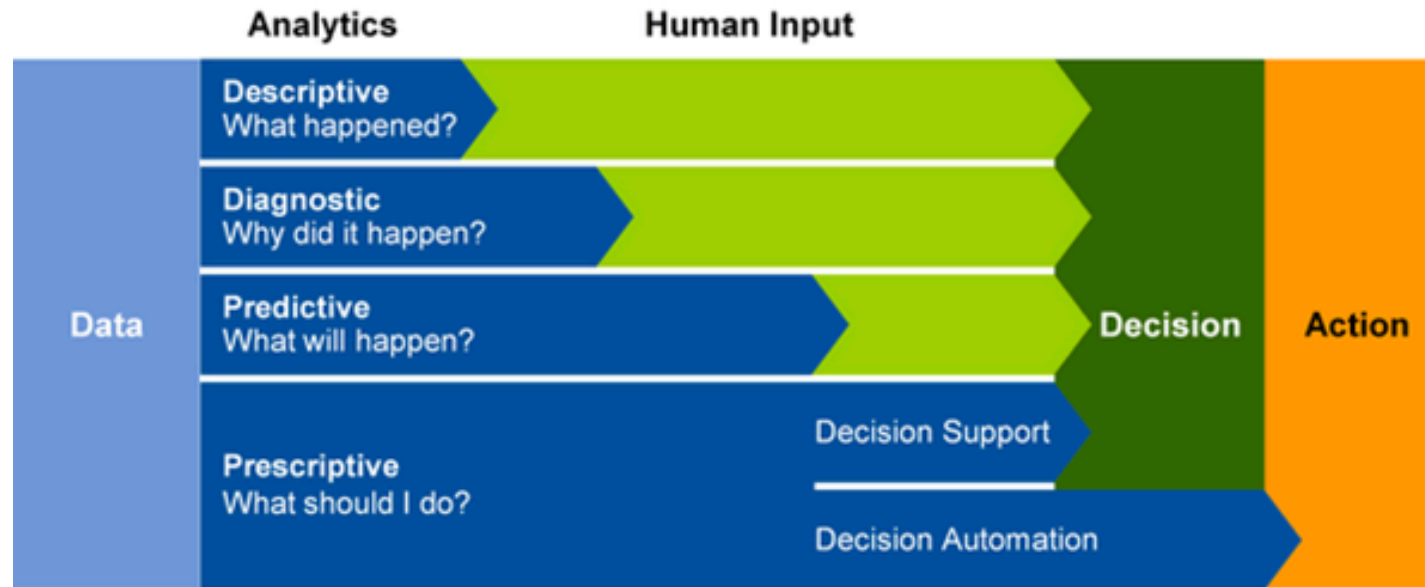
# What is Azure Synapse Analytics?

The technological research and consulting firm Gartner defines four common types of analytical technique that organizations commonly use:

- **Descriptive analytics**, which answers the question “What is happening in my business?”. The data to answer this question is typically answered through the creation of a data warehouse in which historical data is persisted in relational tables for multidimensional modeling and reporting.
- **Diagnostic analytics**, which deals with answering the question “Why is it happening?”. This may involve exploring information that already exists in a data warehouse, but typically involves a wider search of your data estate to find more data to support this type of analysis.
- **Predictive analytics**, which enables you to answer the question “What is likely to happen in the future based on previous trends and patterns?”
- **Prescriptive analytics**, which enables autonomous decision making based on real-time or near real-time analysis of data, using predictive analytics.



# Azure Synapse Analytics



Azure Synapse Analytics provides a cloud platform for all of these analytical workloads through support for multiple data storage, processing, and analysis technologies in a single, integrated solution. The integrated design of Azure Synapse Analytics enables organizations to leverage investments and skills in multiple commonly used data technologies, including SQL, Apache Spark, and others; while providing a centrally managed service and a single, consistent user interface.

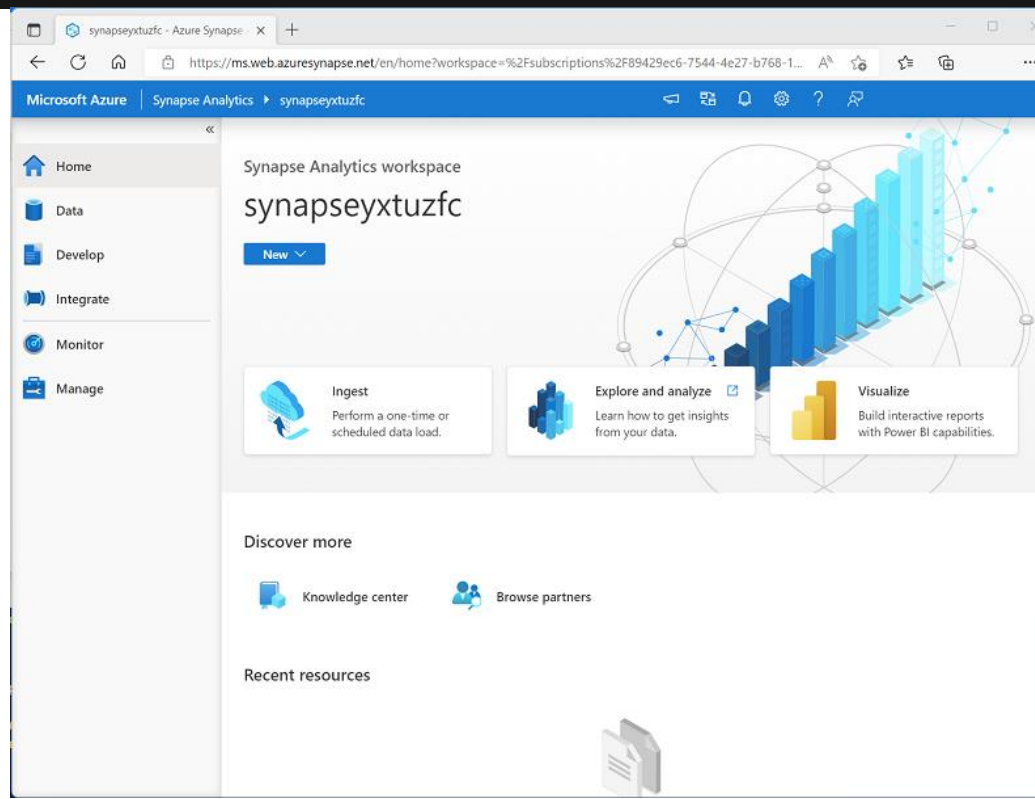




# Creating and using an Azure Synapse Analytics workspace

A Synapse Analytics *workspace* defines an instance of the Synapse Analytics service in which you can manage the services and data resources needed for your analytics solution. You can create a Synapse Analytics workspace in an Azure subscription interactively by using the Azure portal, or you can automate deployment by using Azure PowerShell, the Azure command-line interface (CLI), or with an Azure Resource Manager or Bicep template.

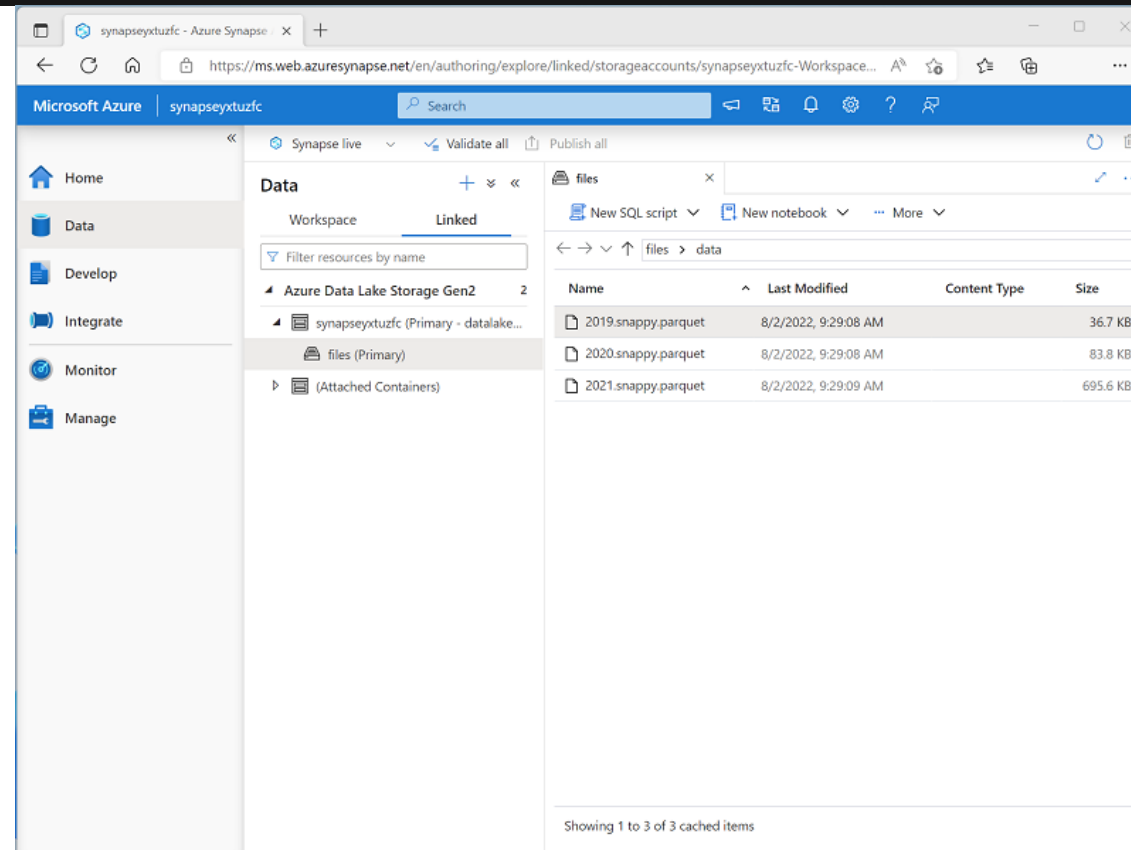
After creating a Synapse Analytics workspace, you can manage the services in it and perform data analytics tasks with them by using *Synapse Studio*; a web-based portal for Azure Synapse Analytics.



# Creating and using an Azure Synapse Analytics workspace

## Working with files in a data lake

One of the core resources in a Synapse Analytics workspace is a *data lake*, in which data files can be stored and processed at scale. A workspace typically has a default data lake, which is implemented as a linked service to an Azure Data Lake Storage Gen2 container. You can add linked services for multiple data lakes that are based on different storage platforms as required.



The screenshot displays the Azure Synapse Analytics workspace interface. The left sidebar shows navigation options: Home, Data, Develop, Integrate, Monitor, and Manage. The main area is titled 'Data' and shows a 'Workspace' tab with a 'Linked' sub-tab. A search bar is present. Below the search bar, there is a list of linked services: 'Azure Data Lake Storage Gen2' (2 items) and 'synapsextzfc (Primary - datalake...)'. The 'files (Primary)' link is selected, leading to a view of the data lake. The view shows a table of files with columns: Name, Last Modified, Content Type, and Size. The table contains three rows of data:

Name	Last Modified	Content Type	Size
2019.snappy.parquet	8/2/2022, 9:29:08 AM		36.7 KB
2020.snappy.parquet	8/2/2022, 9:29:08 AM		83.8 KB
2021.snappy.parquet	8/2/2022, 9:29:09 AM		695.6 KB

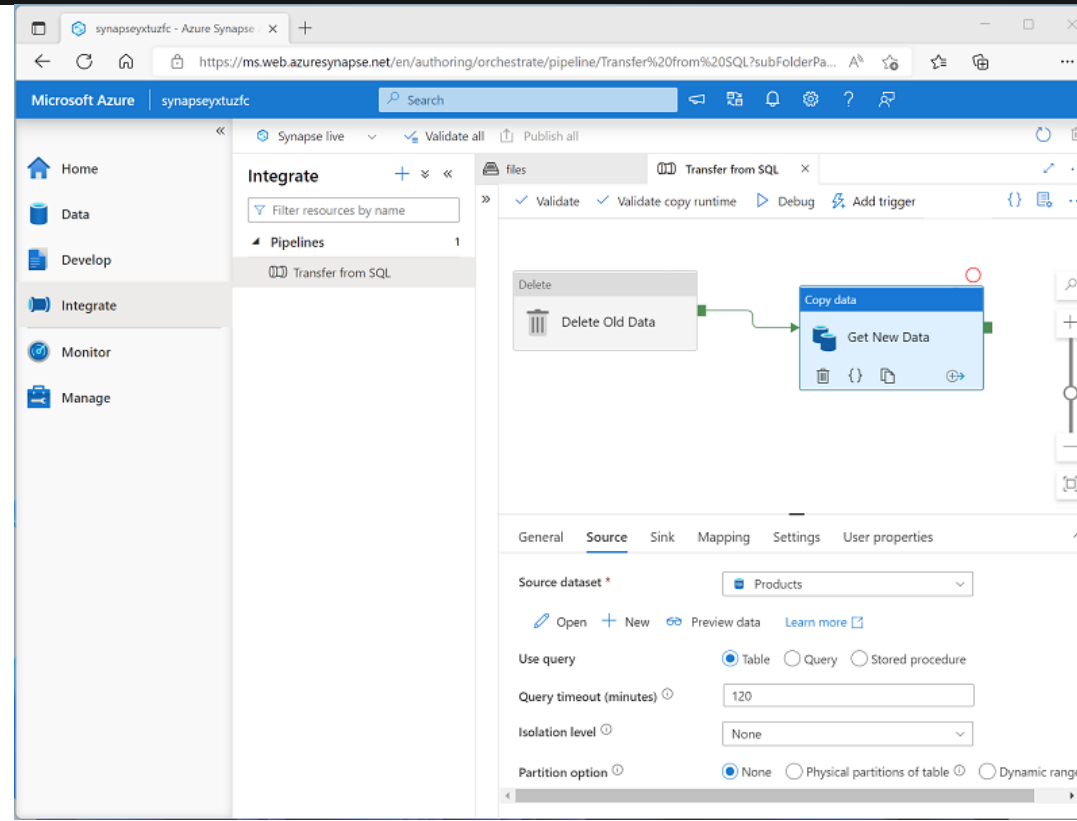
At the bottom, it says 'Showing 1 to 3 of 3 cached items'.



# Creating and using an Azure Synapse Analytics workspace

## Ingesting and transforming data with pipelines

In most enterprise data analytics solutions, data is extracted from multiple operational sources and transferred to a central data lake or data warehouse for analysis. Azure Synapse Analytics includes built-in support for creating, running, and managing *pipelines* that orchestrate the activities necessary to retrieve data from a range of sources, transform the data as required, and load the resulting transformed data into an analytical store.



# Creating and using an Azure Synapse Analytics workspace

## Querying and manipulating data with SQL

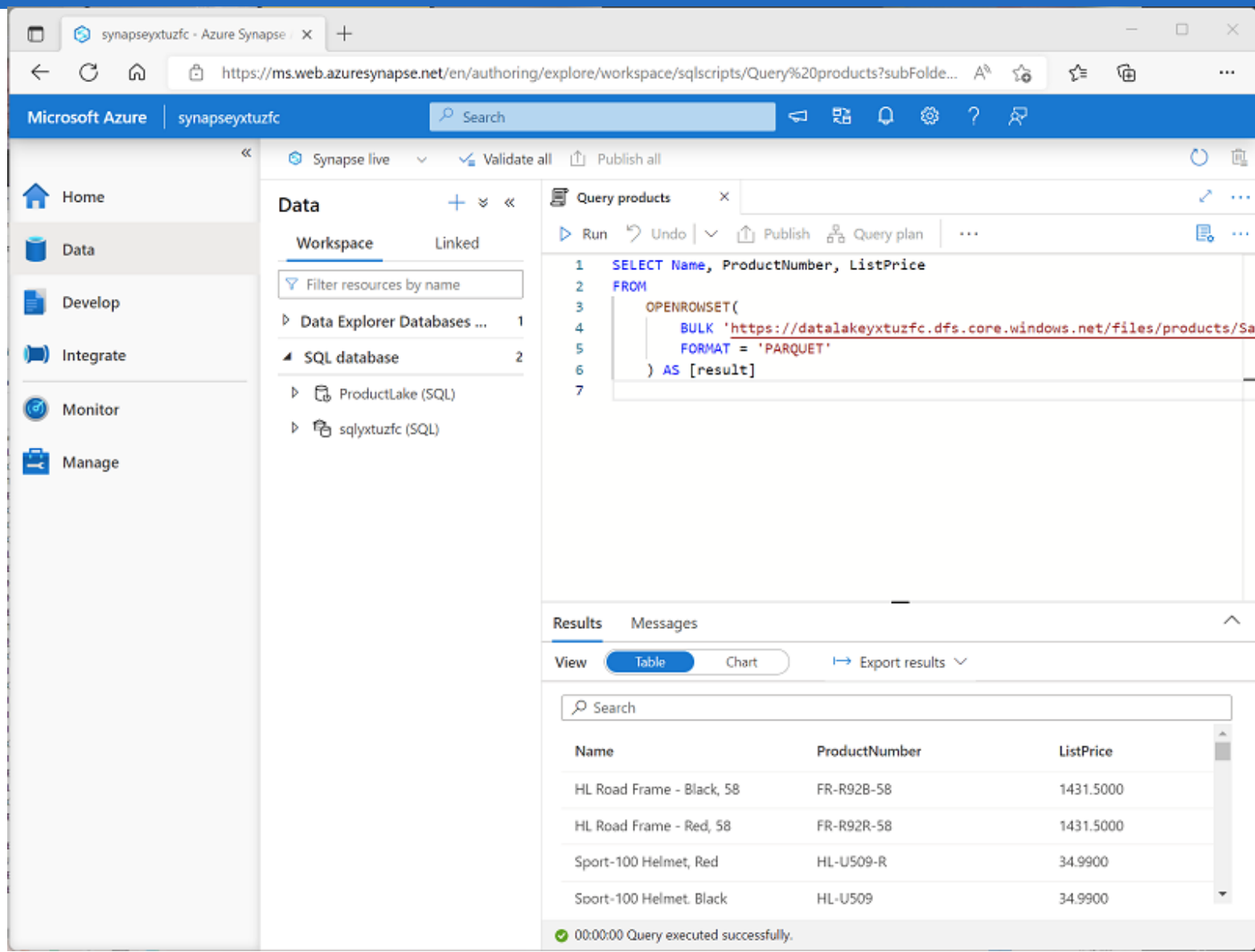
Structured Query Language (SQL) is a ubiquitous language for querying and manipulating data, and is the foundation for relational databases, including the popular Microsoft SQL Server database platform. Azure Synapse Analytics supports SQL-based data querying and manipulation through two kinds of SQL *pool* that are based on the SQL Server relational database engine:

- A built-in *serverless* pool that is optimized for using relational SQL semantics to query file-based data in a data lake.
- Custom *dedicated* SQL pools that host relational data warehouses.

The Azure Synapse SQL system uses a distributed query processing model to parallelize SQL operations, resulting in a highly scalable solution for relational data processing. You can use the built-in serverless pool for cost-effective analysis and processing of file data in the data lake, and use dedicated SQL pools to create relational data warehouses for enterprise data modeling and reporting.



# Creating and using an Azure Synapse Analytics workspace



The screenshot displays the Azure Synapse Analytics workspace interface. The left sidebar shows navigation options: Home, Data, Develop, Integrate, Monitor, and Manage. The main area is divided into two panes. The left pane, titled 'Data', shows a 'Workspace' view with a list of resources: 'Data Explorer Databases ...' (1) and 'SQL database' (2). Under 'SQL database', there are two entries: 'ProductLake (SQL)' and 'sqlyxtuzfc (SQL)'. The right pane, titled 'Query products', shows a SQL query being executed. The query is as follows:

```
1 SELECT Name, ProductNumber, ListPrice
2 FROM
3 OPENROWSET(
4     BULK 'https://datalakeyxtuzfc.dfs.core.windows.net/files/products/Sa
5     FORMAT = 'PARQUET'
6 ) AS [result]
7
```

Below the query editor, the 'Results' pane shows the output of the query. The results are displayed in a table view with the following columns: Name, ProductNumber, and ListPrice. The table contains five rows of data:

Name	ProductNumber	ListPrice
HL Road Frame - Black, 58	FR-R92B-58	1431.5000
HL Road Frame - Red, 58	FR-R92R-58	1431.5000
Sport-100 Helmet, Red	HL-U509-R	34.9900
Sport-100 Helmet, Black	HL-U509	34.9900

At the bottom of the interface, a status bar indicates that the query was executed successfully: '00:00:00 Query executed successfully.'



# Creating and using an Azure Synapse Analytics workspace

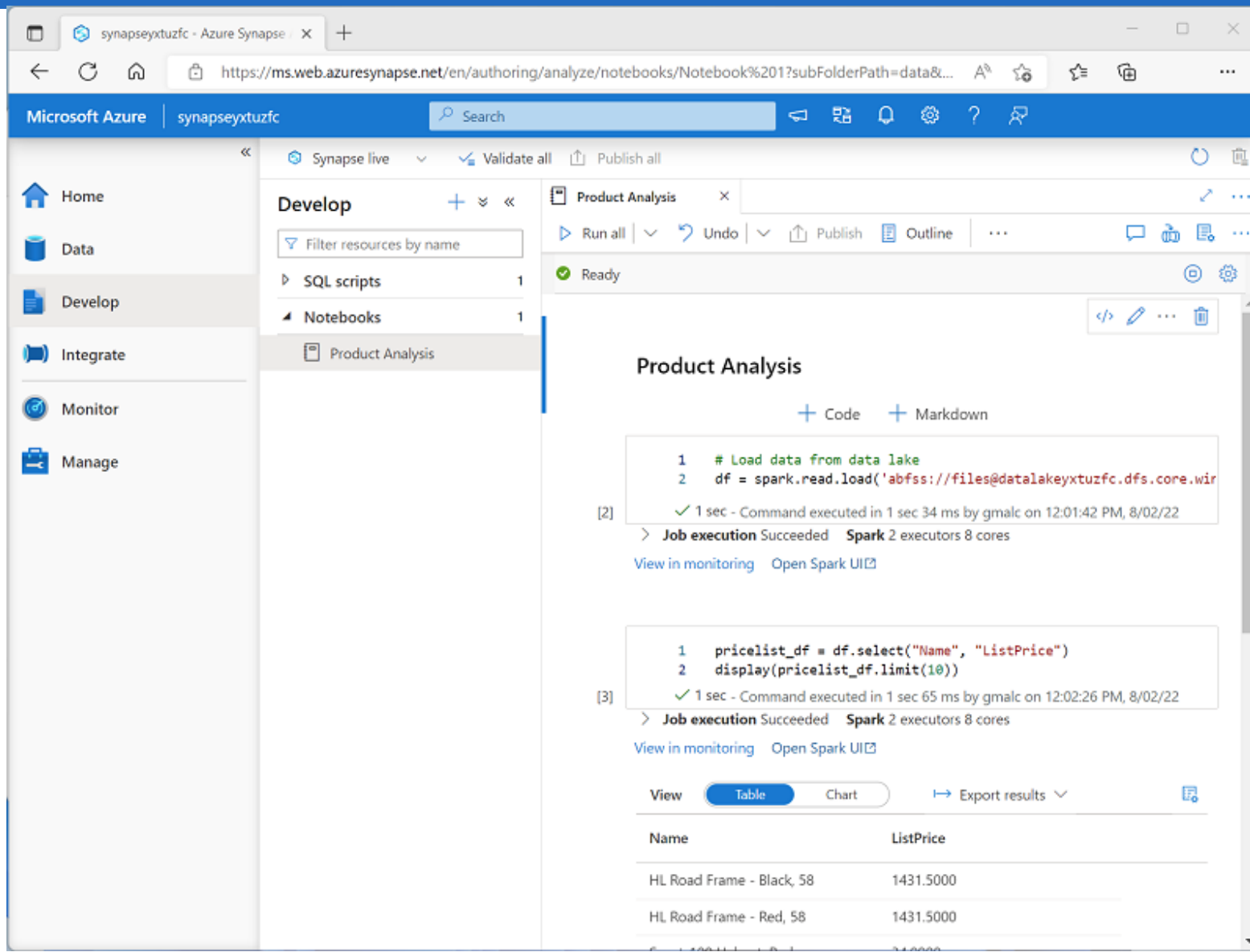
## Processing and analyzing data with Apache Spark

Apache Spark is an open source platform for big data analytics. Spark performs distributed processing of files in a data lake by running jobs that can be implemented using any of a range of supported programming languages. Languages supported in Spark include Python, Scala, Java, SQL, and C#.

In Azure Synapse Analytics, you can create one or more Spark pools and use interactive *notebooks* to combine code and notes as you build solutions for data analytics, machine learning, and data visualization.



# Creating and using an Azure Synapse Analytics workspace



The screenshot displays the Azure Synapse Analytics workspace interface. The left sidebar shows navigation options: Home, Data, Develop, Integrate, Monitor, and Manage. The 'Develop' section is active, showing a list of resources including 'SQL scripts' and 'Notebooks'. The 'Product Analysis' notebook is selected, and its content is displayed in the main area. The notebook contains two code blocks, each followed by its execution status and output.

**Product Analysis**

**Code Block 1:**

```
1 # Load data from data lake
2 df = spark.read.load('abfss://files@datalakeyxtuzfc.dfs.core.wir
```

**Execution Status:** [2] ✓ 1 sec - Command executed in 1 sec 34 ms by gmalc on 12:01:42 PM, 8/02/22  
Job execution Succeeded Spark 2 executors 8 cores  
[View in monitoring](#) [Open Spark UI](#)

**Code Block 2:**

```
1 pricelist_df = df.select("Name", "ListPrice")
2 display(pricelist_df.limit(10))
```

**Execution Status:** [3] ✓ 1 sec - Command executed in 1 sec 65 ms by gmalc on 12:02:26 PM, 8/02/22  
Job execution Succeeded Spark 2 executors 8 cores  
[View in monitoring](#) [Open Spark UI](#)

**View:** Table Chart Export results

Name	ListPrice
HL Road Frame - Black, 58	1431.5000
HL Road Frame - Red, 58	1431.5000



# Creating and using an Azure Synapse Analytics workspace

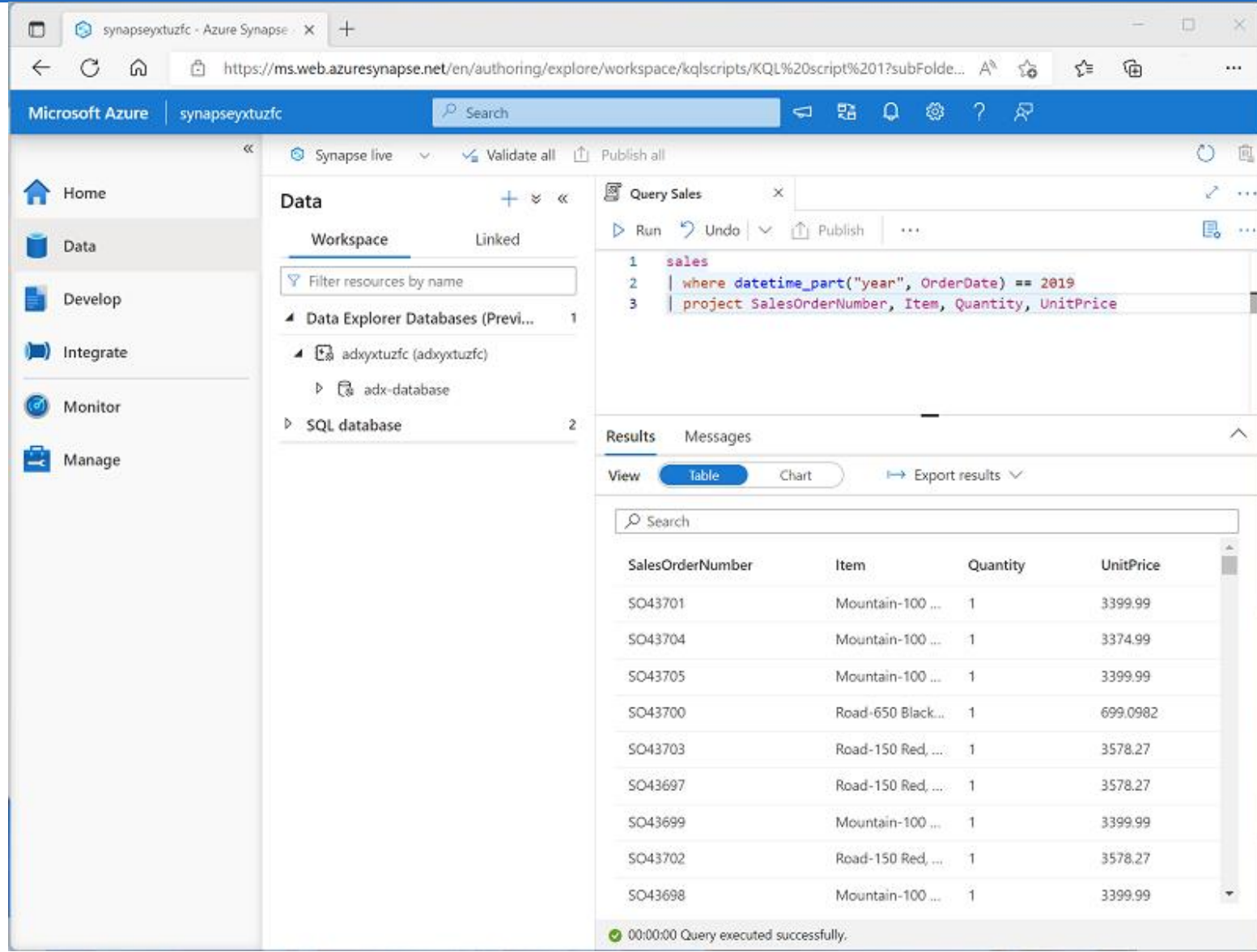
## Exploring data with Data Explorer

Azure Synapse Data Explorer is a data processing engine in Azure Synapse Analytics that is based on the Azure Data Explorer service. Data Explorer uses an intuitive query syntax named Kusto Query Language (KQL) to enable high performance, low-latency analysis of batch and streaming data.





# Creating and using an Azure Synapse Analytics workspace



The screenshot displays the Azure Synapse Analytics workspace interface. The left sidebar contains navigation options: Home, Data, Develop, Integrate, Monitor, and Manage. The main area is divided into three sections: a 'Data' pane on the left, a 'Query Sales' editor in the center, and a 'Results' pane on the right.

The 'Data' pane shows a 'Workspace' tab with a search bar and a list of resources. Under 'Data Explorer Databases (Previous)', there is a folder named 'adxxtuzfc (adxxtuzfc)' containing an 'adx-database'. Below this, a 'SQL database' is listed with a count of 2.

The 'Query Sales' editor shows a SQL query:

```
1 sales
2 | where datetime_part("year", OrderDate) == 2019
3 | project SalesOrderNumber, Item, Quantity, UnitPrice
```

The 'Results' pane shows a table view of the query results. The table has four columns: SalesOrderNumber, Item, Quantity, and UnitPrice. The results are displayed in a table format with a search bar and a 'View' dropdown set to 'Table'. The 'Export results' button is also visible.

SalesOrderNumber	Item	Quantity	UnitPrice
SO43701	Mountain-100 ...	1	3399.99
SO43704	Mountain-100 ...	1	3374.99
SO43705	Mountain-100 ...	1	3399.99
SO43700	Road-650 Black...	1	699.0982
SO43703	Road-150 Red, ...	1	3578.27
SO43697	Road-150 Red, ...	1	3578.27
SO43699	Mountain-100 ...	1	3399.99
SO43702	Road-150 Red, ...	1	3578.27
SO43698	Mountain-100 ...	1	3399.99

A status bar at the bottom indicates: 00:00:00 Query executed successfully.



# Integrating with other Azure data services

Azure Synapse Analytics can be integrated with other Azure data services for end-to-end analytics solutions. Integrated solutions include:

- **Azure Synapse Link** enables near-realtime synchronization between operational data in Azure Cosmos DB, Azure SQL Database, SQL Server, and Microsoft Power Platform Dataverse and analytical data storage that can be queried in Azure Synapse Analytics.
- **Microsoft Power BI** integration enables data analysts to integrate a Power BI workspace into a Synapse workspace, and perform interactive data visualization in Azure Synapse Studio.
- **Microsoft Purview** integration enables organizations to catalog data assets in Azure Synapse Analytics, and makes it easier for data engineers to find data assets and track data lineage when implementing data pipelines that ingest data into Azure Synapse Analytics.
- **Azure Machine Learning** integration enables data analysts and data scientists to integrate predictive model training and consumption into analytical solutions.

