



Power BI Architecture End-to-End

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Slides & recordings: CoatesDS.com/Presentations

Content last updated: March 10, 2021

Melissa Coates



Owner of [Coates Data Strategies](#) | [@SQLChick](#) | [@CoatesDS](#)

Data architect specializing in Power BI governance & administration

Author of [Power BI Adoption Roadmap](#)

Author of [Planning a Power BI Enterprise Deployment](#)

Creator of [Power BI Deployment & Governance](#) online course

Power BI Deployment & Governance

Comprehensive online course



Governance
Adoption & data culture
Center of Excellence
Data architecture
Content management
Data trustworthiness
Security & protection
System oversight

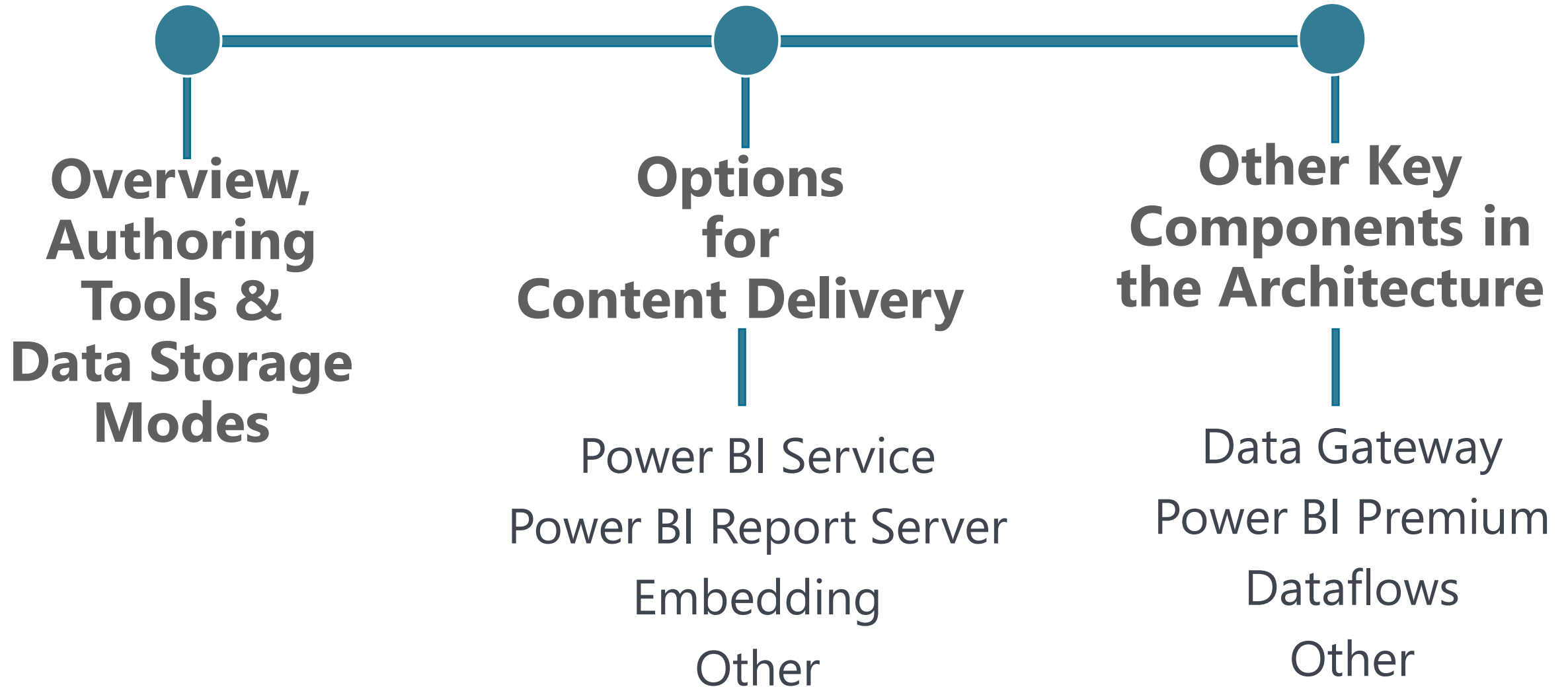


Comprehensive set of video recordings
Live group Q&A sessions
Live hands-on workshops
Customizable templates
Recommended actions
Access for 6 months

Power BI Architecture End-to-End



Agenda





Power BI Overview, Authoring Tools & Data Storage Modes



What is Power BI?

A **suite of tools** to support **both** self-service BI and enterprise BI:

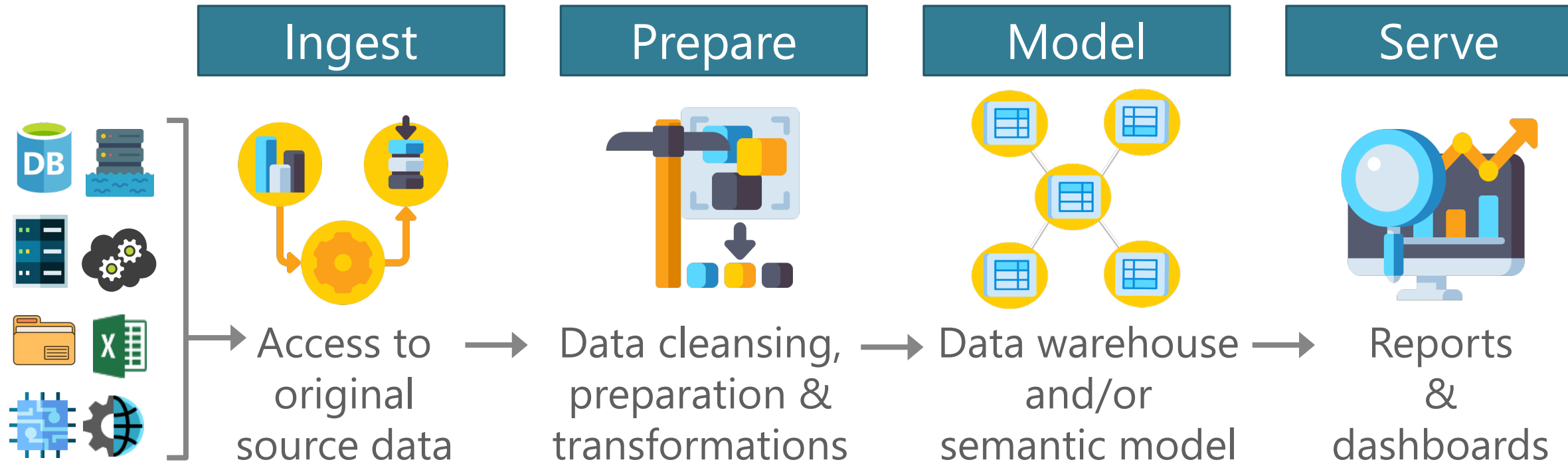
- Data acquisition
- Data preparation & cleansing
- Data modeling
- Calculations
- Reports & visuals
- Content delivery & viewing



Power BI is a broad collection of tools, services, and features



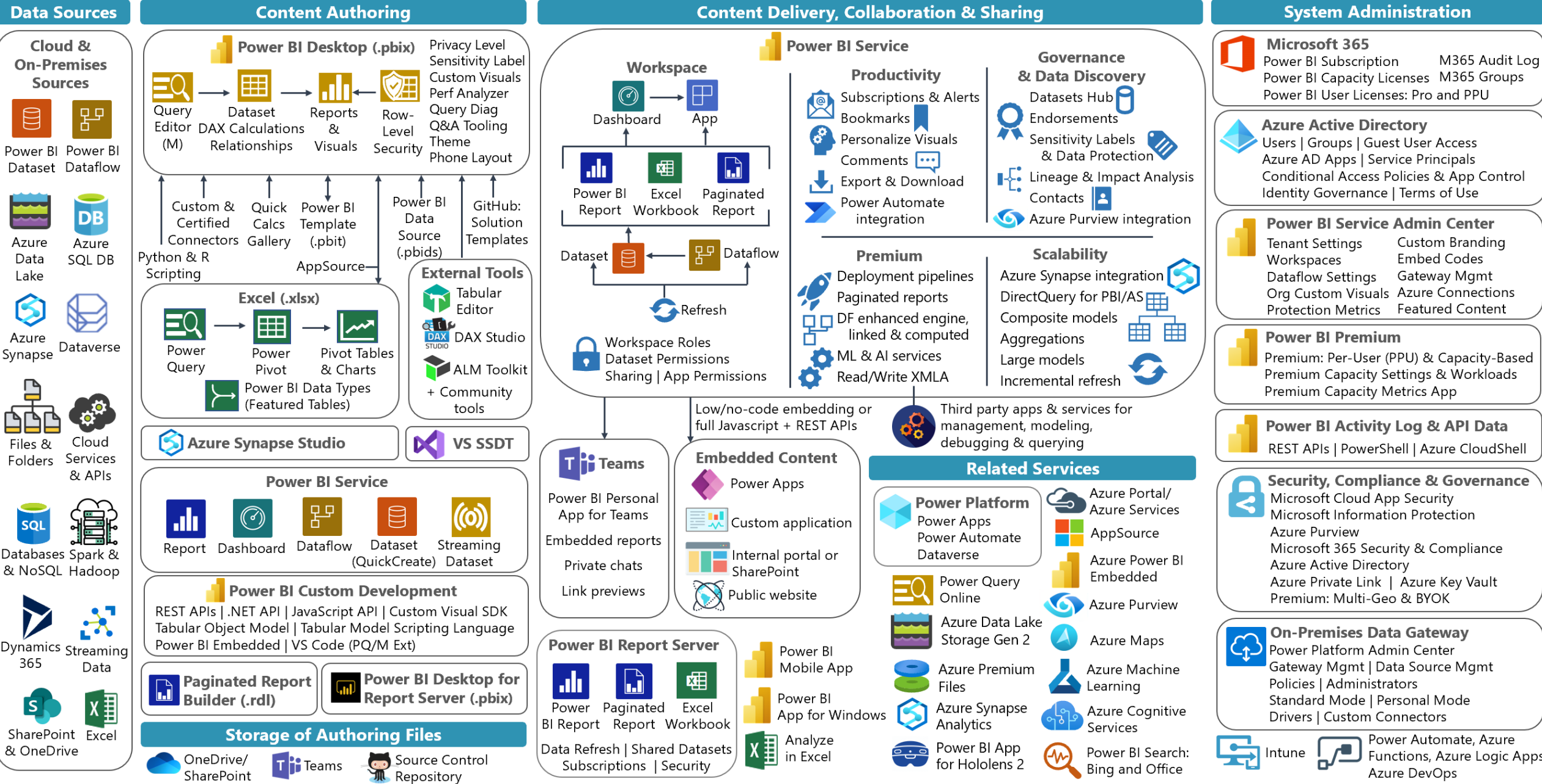
Data Architecture Components



Power BI can be used for some or all of these components

Power BI End-To-End: Top Features, Key Integration Points & Related Services

Last Updated: January 4, 2021

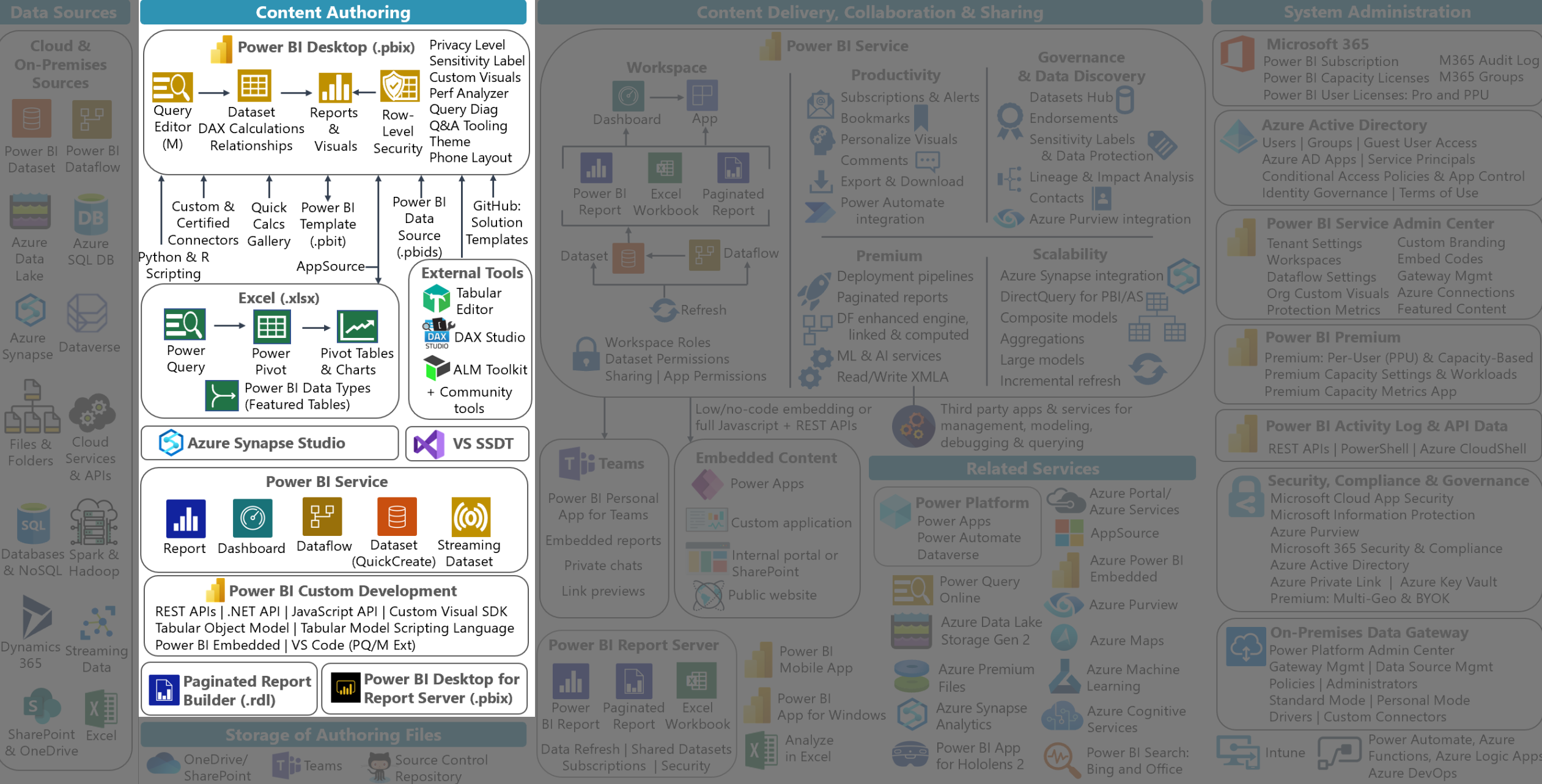


Authoring Tools



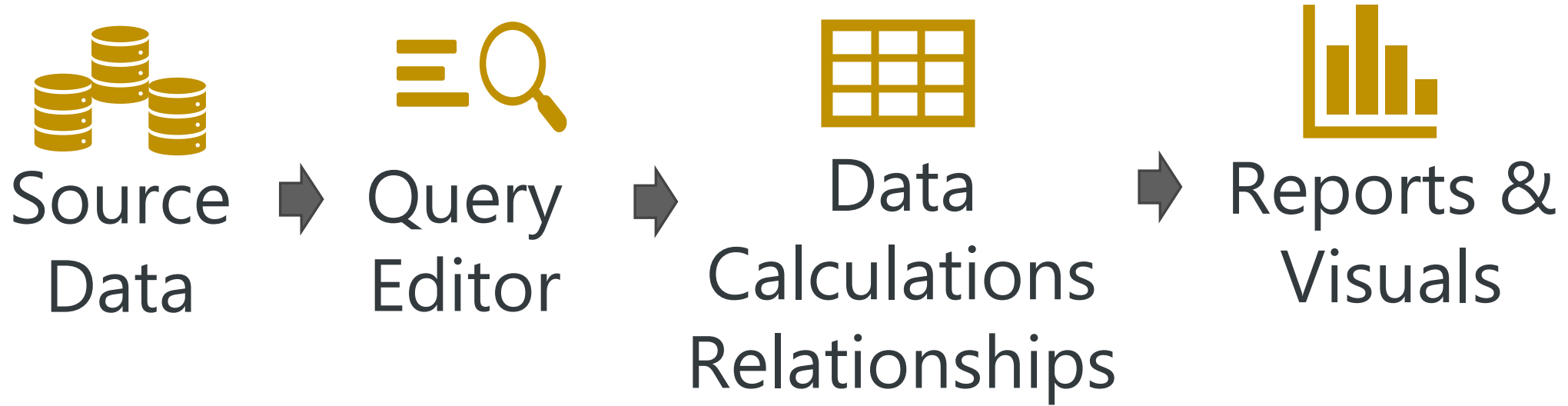
Power BI End-To-End: Top Features, Key Integration Points & Related Services

Last Updated: January 4, 2021





Power BI Authoring



Skills:

Data preparation

Data modeling

Data visualization

Languages:

Power Query
Formula
Language ("M")

Data Analysis
eXpressions
("DAX")

Native Tools for Creating Power BI Content



Power BI Desktop (.pbix) +
Power BI Desktop for Report Server (.pbix)



Power BI Paginated Report Builder (.rdl)



Excel (.xlsx)



Power BI Service



Azure Synapse Studio



Visual Studio Code



Visual Studio SQL Server Data Tools

Tools for Creating Content



Native tools intended for self-service authors:



Power BI
Desktop



Excel



Paginated
Report Builder



Power BI
Service

Native tools intended for more advanced authors:



Azure Synapse
Studio



Visual Studio
Code



Visual Studio
SQL Server Data Tools

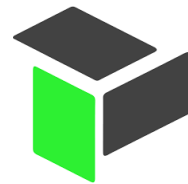
External tools for advanced dataset authoring & deployment:



DAX
Studio



Tabular
Editor



ALM
Toolkit

+ many more
community tools



Data Storage Modes



Dataset Storage Modes

**Data
stored in
Power BI**

**Data
remains
in source**

Import

Data is imported to Power BI's in-memory columnar data storage



DirectQuery

Queries are passed at execution time to a relational data source



Live Connection

Queries are passed at execution time to an Analysis Services model or a Power BI dataset



Composite Model

A combination of Import, Live Connection and/or DirectQuery



Forms of data virtualization: querying the data where it lives

Terminology Clarifications



Live Connection -vs- DirectQuery

Conceptually similar in that they both query data which resides elsewhere.

Examples:

- Live Connection from a report to a Power BI dataset or Azure AS
- DirectQuery from a report to an Azure SQL Database

Two Types of DirectQuery

- (1) DirectQuery to (usually) a relational database ← *Standard DirectQuery mode*
- (2) DirectQuery for Power BI datasets & Azure Analysis Services models ← *One type of composite model*

Data Storage Modes

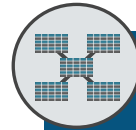


	Local model	Remote model
Data stored in Power BI	<p>Import Mode A PBIX file which contains both the schema & the data</p>	<p>Live Connection Mode A PBIX file with reports that obtain data by querying a Power BI shared dataset</p>
Data remains in source	<p>DirectQuery Mode A PBIX file which contains a model that is schema only; data is obtained by querying the data source when report is executed</p>	<p>Live Connection Mode A PBIX file with reports that obtain data by querying an Analysis Services Tabular Model</p>

Using a Shared Dataset w/ Live Connection



Shared dataset:



Sales Analysis
Dataset

Reports make a live connection to
the remote model to access data



Reports:



YTD Sales
Revenue



Daily Sales
Targets



Sales by
Product



MoM
Sales
Trends

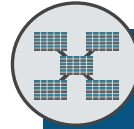
Extending & Customizing a Shared Dataset



DirectQuery for Power BI Datasets and Azure Analysis Services



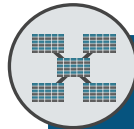
Shared dataset:



Organizational Sales Analysis Dataset



Composite model:



Departmental Sales Analysis Dataset

Live Connection is converted to a DirectQuery connection

Organizational data:
DirectQuery to remote model

+

Departmental data:
Local model



Customize & extend organizational model with additional data sources & calculations



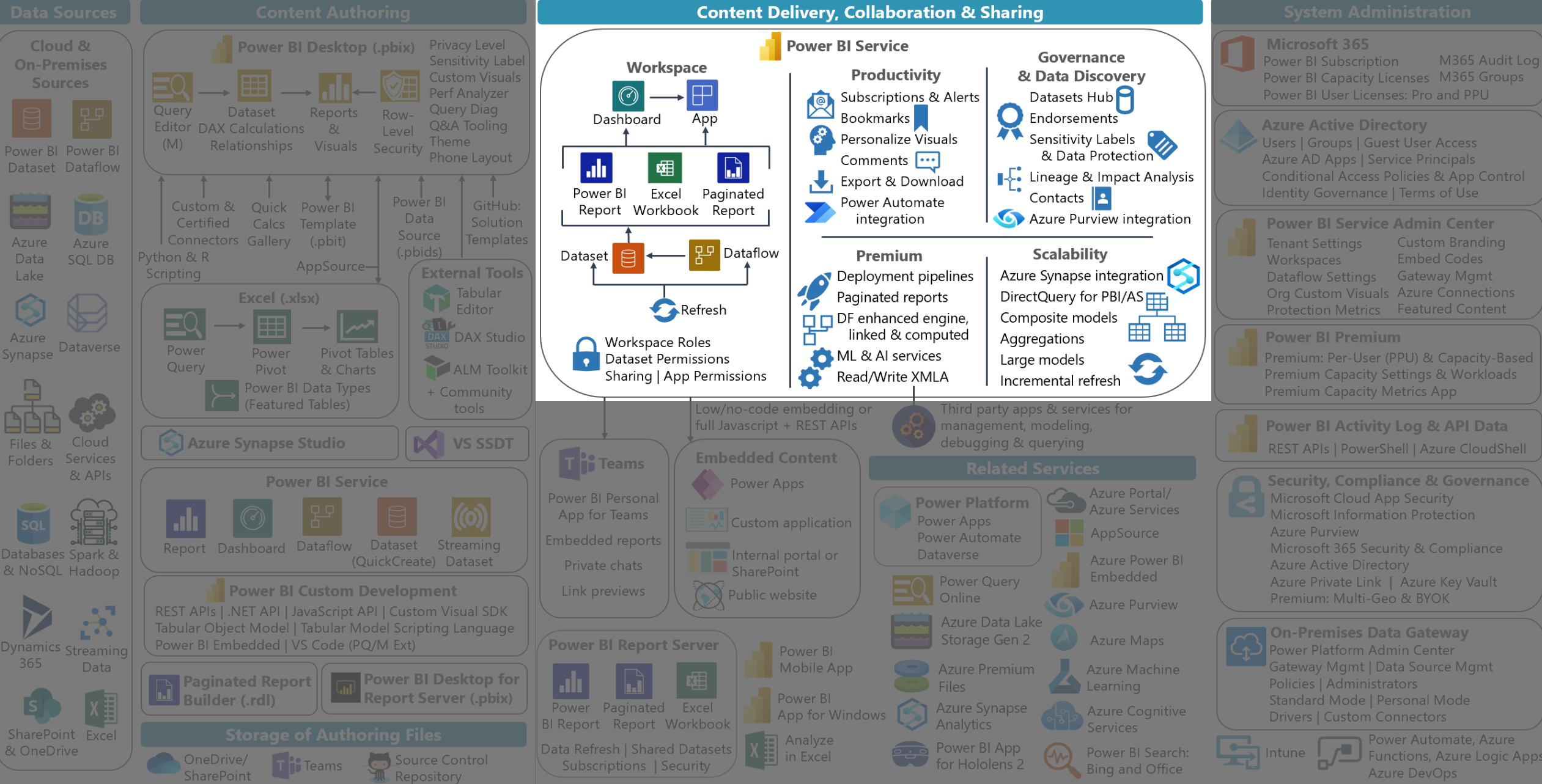
Options for Content Delivery with Power BI



Power BI Service

Power BI End-To-End: Top Features, Key Integration Points & Related Services

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Publishing to the Power BI Service



Power BI Desktop



Excel



Paginated Report Builder



Power BI Service

My Workspace

Workspace A

App A

Workspace B

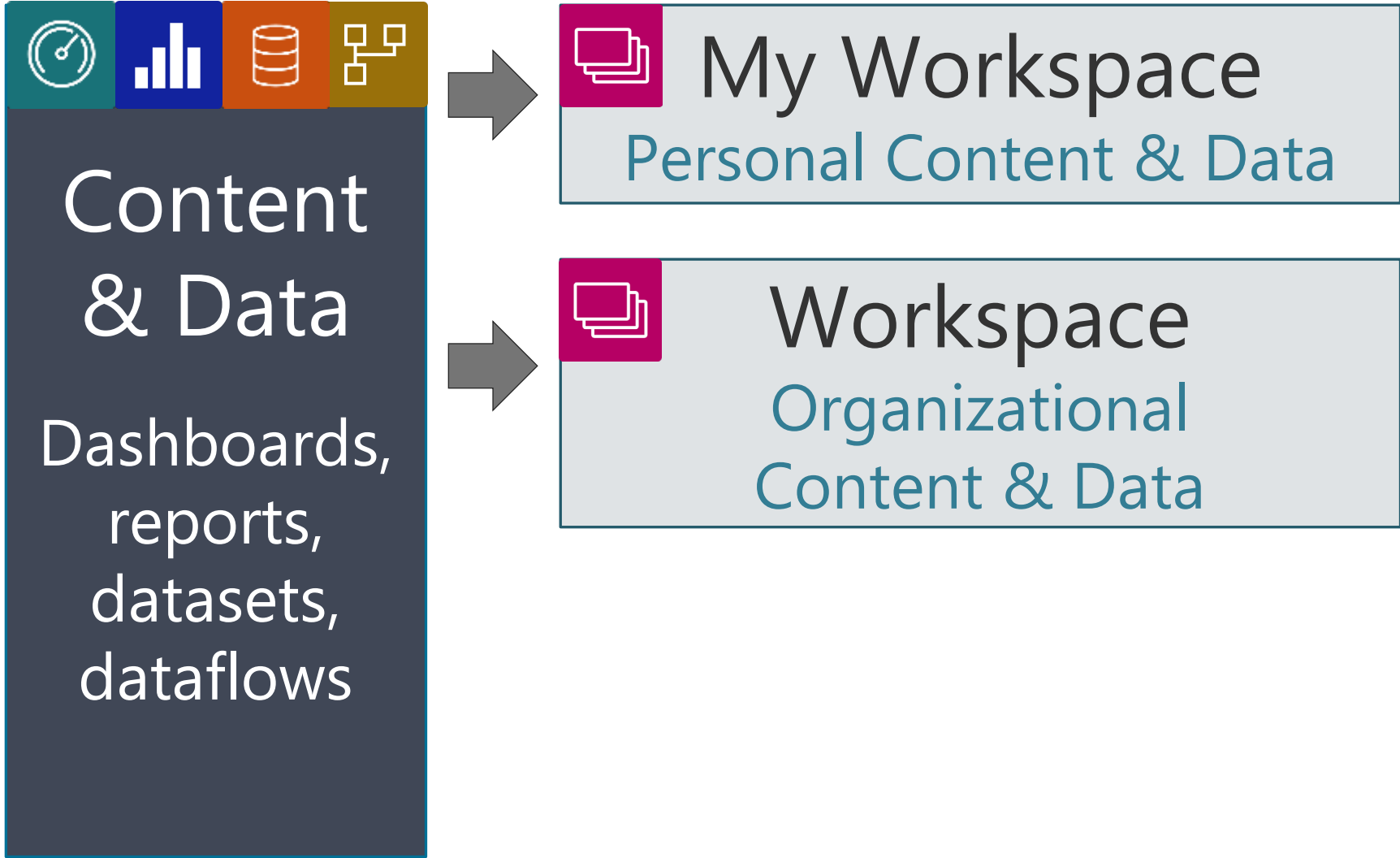
App B

view content

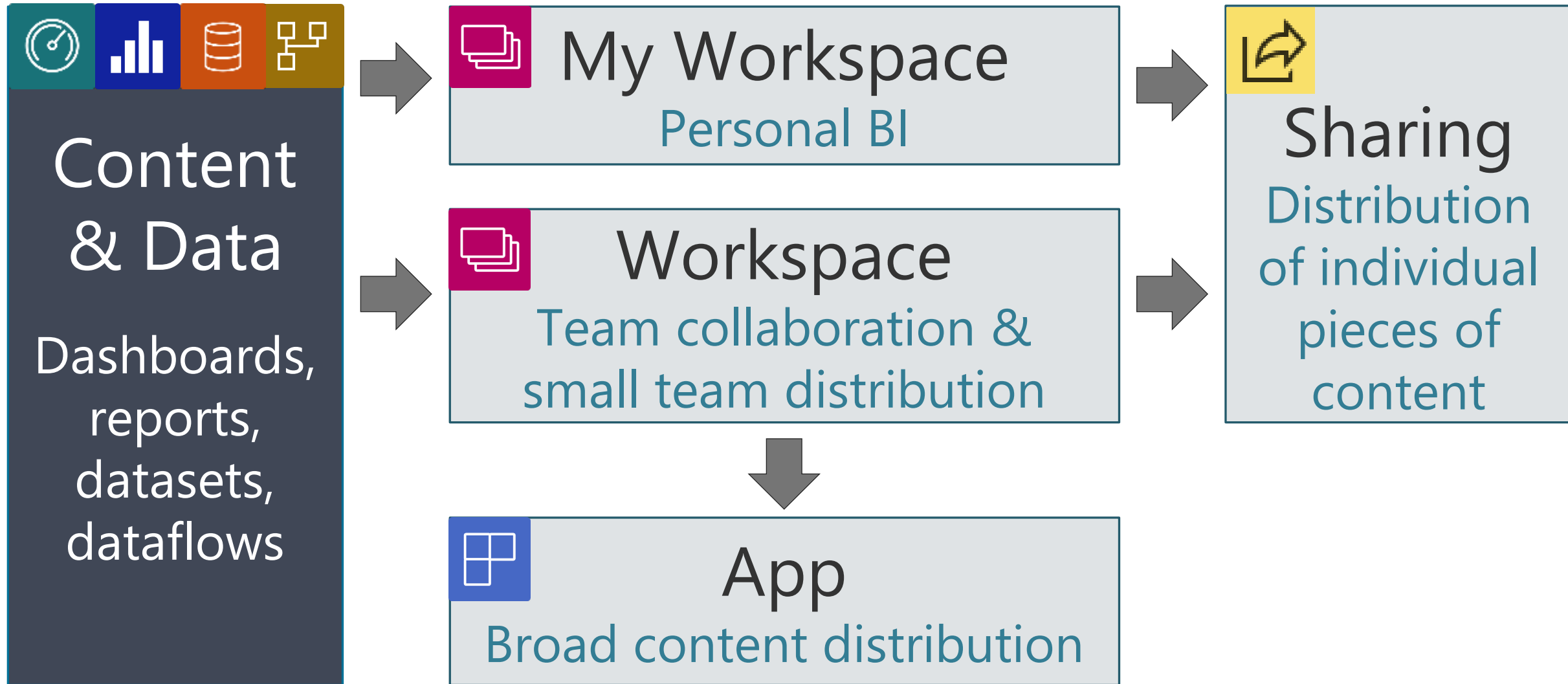


Collaborate on content creation & validation

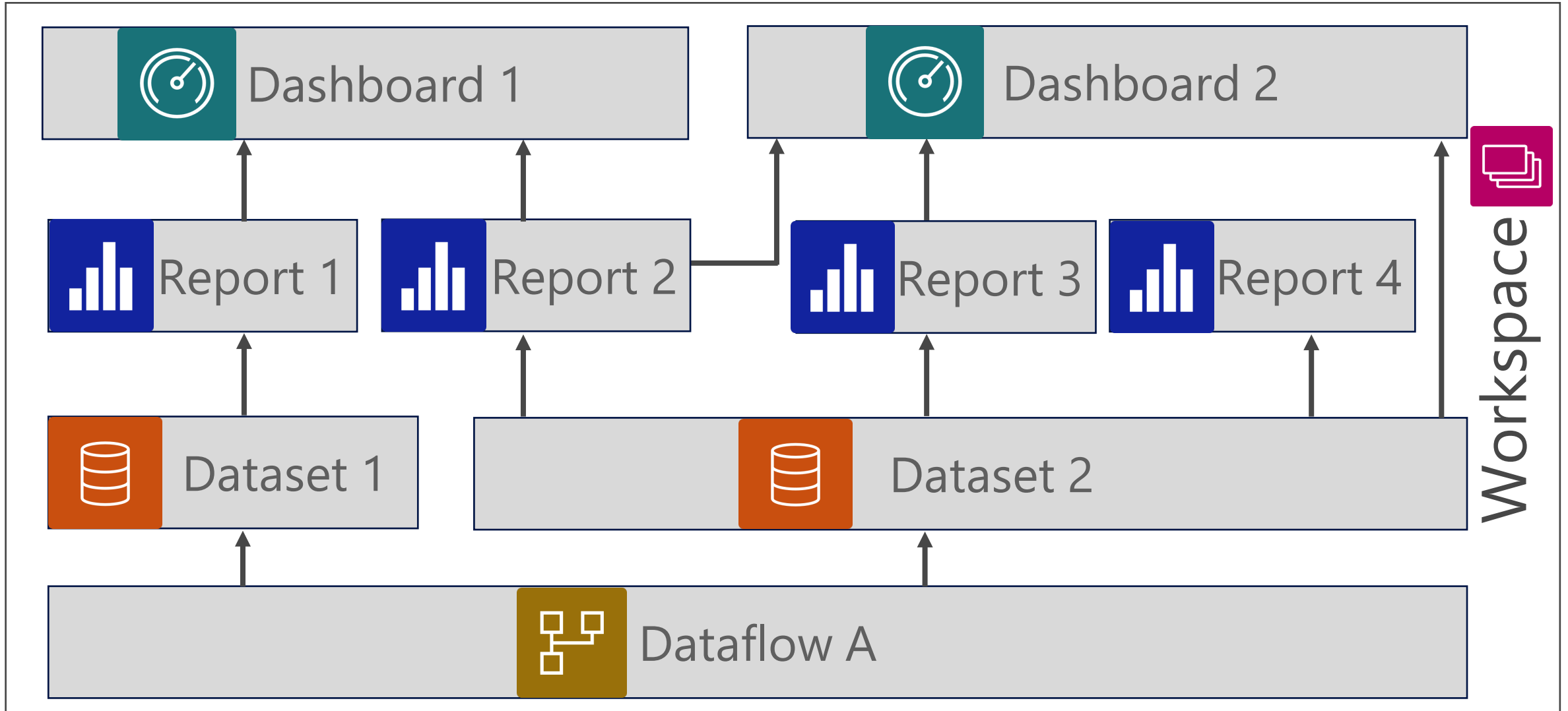
Storing Content in the Power BI Service



Viewing Content in the Power BI Service



Objects in the Power BI Service





Licenses for Using Power BI Service

User Licenses:

Free

Personal analytics (my workspace)

Pro

Team collaboration and content distribution (workspaces, apps, sharing)

PPU

Add-on to Pro for most Premium features

User identity from Azure Active Directory

Core-Based Capacity Licenses (*optional*):

Premium

Broad content distribution scenarios + additional features

Top Reasons for Using the Power BI Service

Collaboration, Sharing & Content Distribution



Delivering reports using Power BI Desktop on a file system is difficult to do well & is not user-friendly



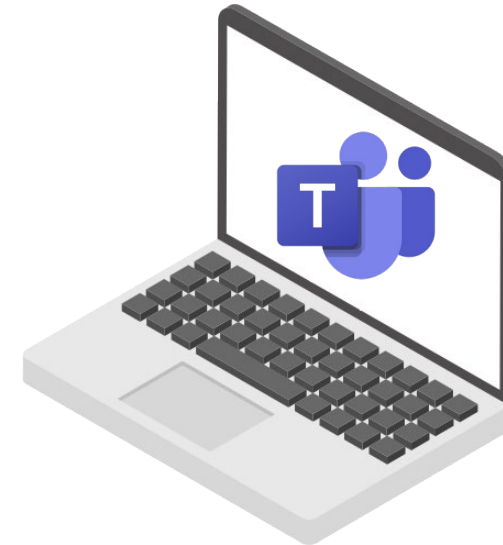
Multiple methods & security options to collaborate with both internal and external users based on Azure Active Directory

Top Reasons for Using the Power BI Service

Collaboration, Sharing & Content Distribution



Friendlier experience for report consumers with apps + easier to discover content



Integration with Microsoft Teams: full capabilities of Power BI Service so users can be productive where they already are working

Top Reasons for Using the Power BI Service



Collaboration, Sharing & Content Distribution



Row-level security works



Use of the Power BI mobile app & the Windows application



Report & dashboard comments

Top Reasons for Using the Power BI Service



Automation



Subscriptions



Scheduled
data refresh

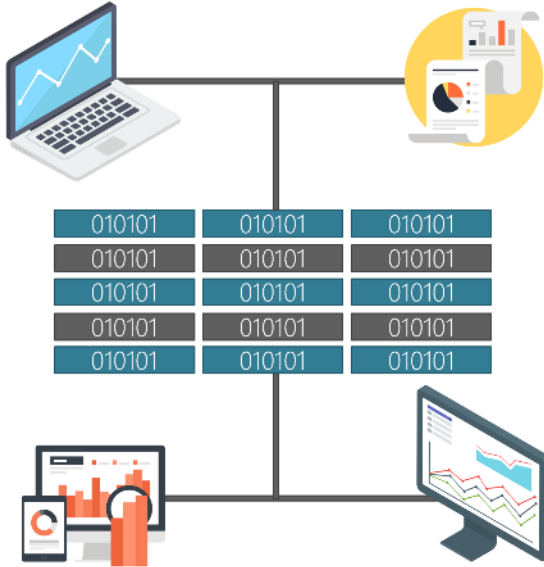


Integration with
Power Automate
& Power Apps

Top Reasons for Using the Power BI Service



Centralization & Reusability



Centralized dataset reusability across numerous reports with shared datasets & live connections

010101	010101	010101
010101	010101	010101
010101	010101	010101
010101	010101	010101
010101	010101	010101



Certified & promoted (endorsements) for datasets & dataflows



Centralized data cleansing with Power BI dataflows

Top Reasons for Using the Power BI Service



Governance, Compliance & Administration



Tenant settings to manage features & user experience + administrator access to all workspaces to support user population



Administrator visibility into usage & activity logging for adoption, administration & support

Top Reasons for Using the Power BI Service



Governance, Compliance & Administration



Integration with
Microsoft 365 information
protection & sensitivity labels



Integration with Microsoft
Cloud App Security to
implement data loss
prevention policies

Power BI Report Server

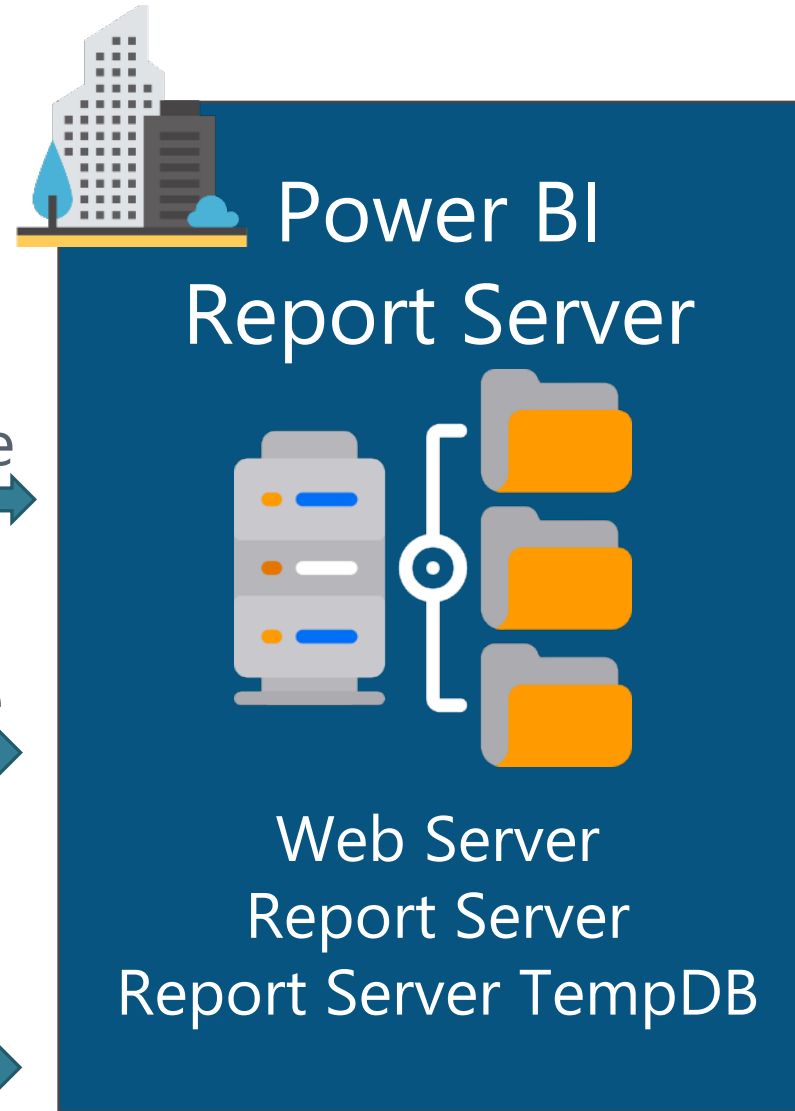
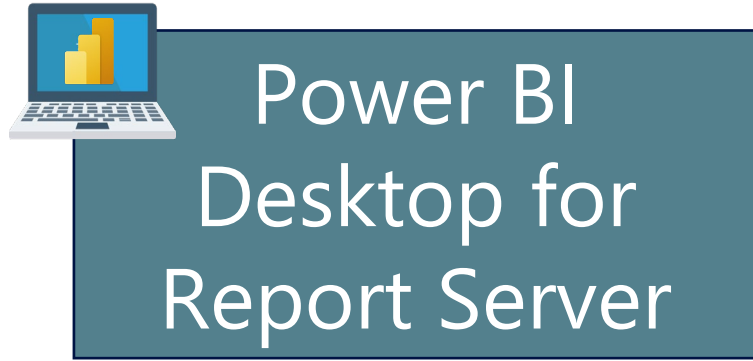


Power BI End-To-End: Top Features, Key Integration Points & Related Services

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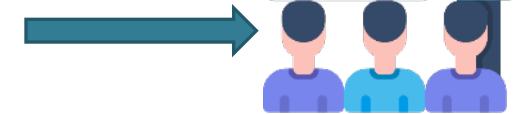
Power BI Report Server (PBIRS)



collaborate on content creation & validation



view content



Top Reasons for Using PBIRS



Need an alternative to the Power BI Service for delivery of reports



Existing significant investment in Reporting Services



Desire a simple folder-based reporting portal; a slower release cadence & a subset of feature support is ok

Embedding Solutions



Power BI End-To-End: Top Features, Key Integration Points & Related Services

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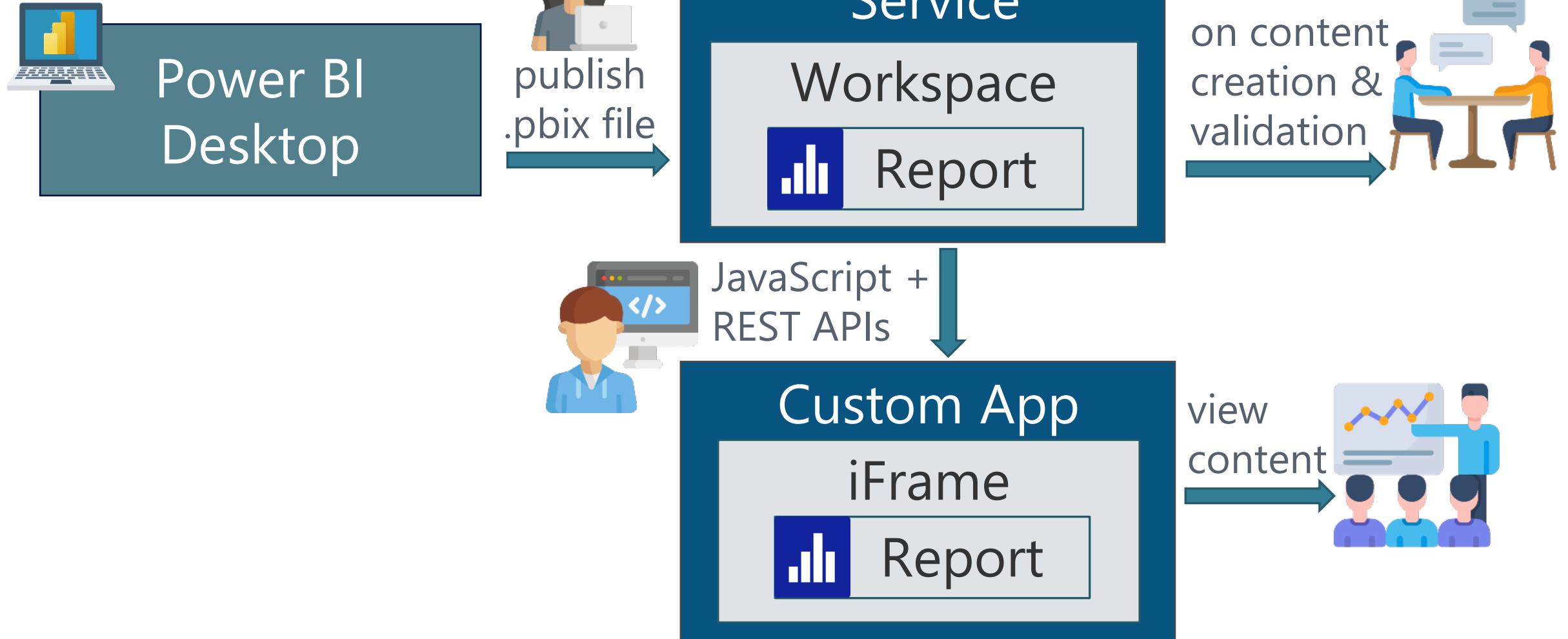


Low/no-code embedding or full Javascript + REST APIs

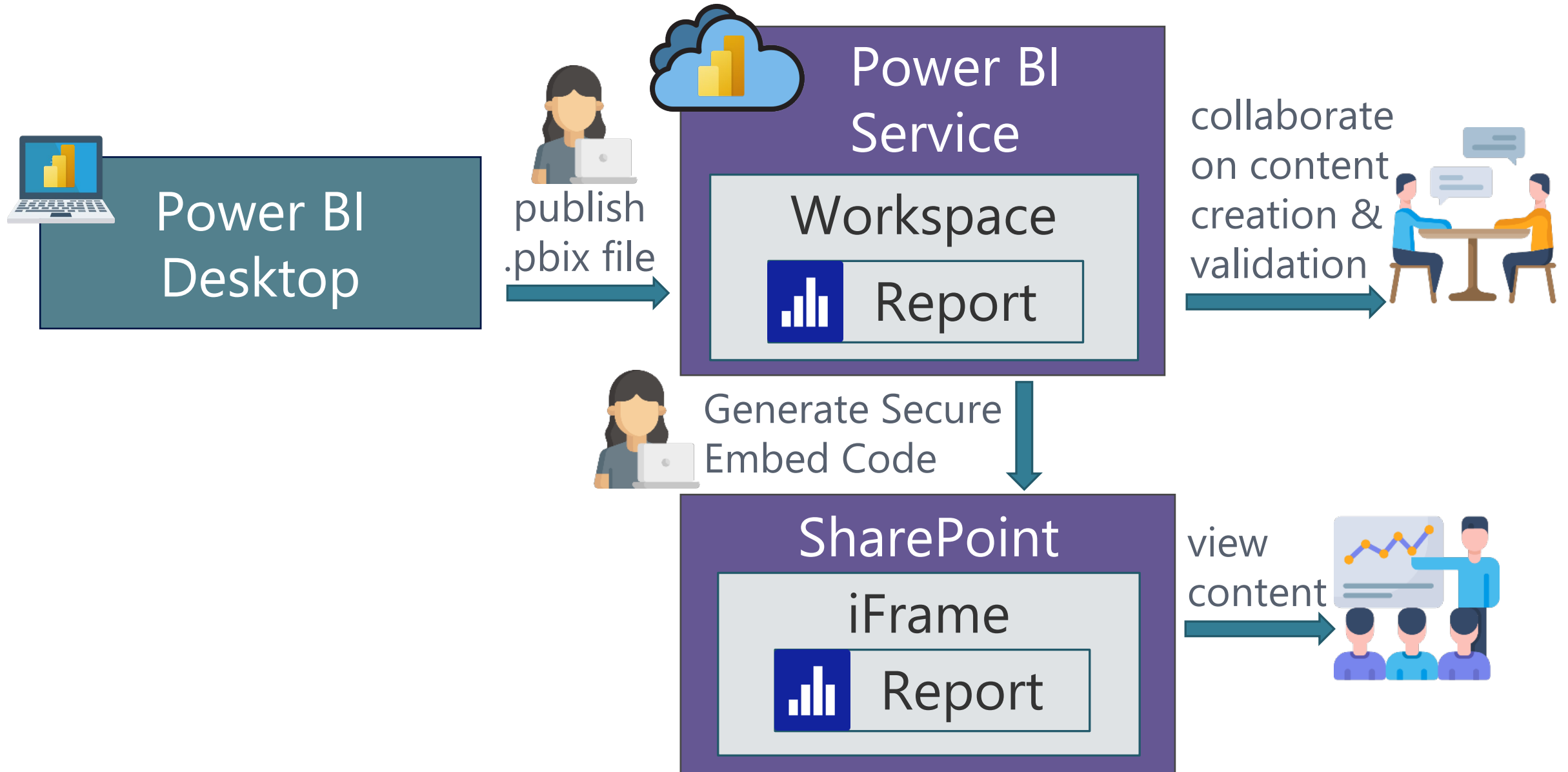
Embedded Content

- Power Apps
- Custom application
- Internal portal or SharePoint
- Public website

Embedding Content in a Custom App



No-Code Embedding



Options for Embedding Content



Internal Embedding

External Embedding

Embed for productivity
(no-code)

Embed for
your org
(user owns data)

Embed for
customers
(app owns data)

Public



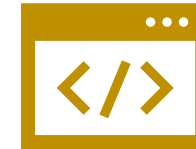
URL Embedding
for internal websites
and portals

Embedding
in
Teams

Embedding
in
SharePoint



REST APIs:
Custom portals
and custom apps



REST APIs:
ISV apps and
services



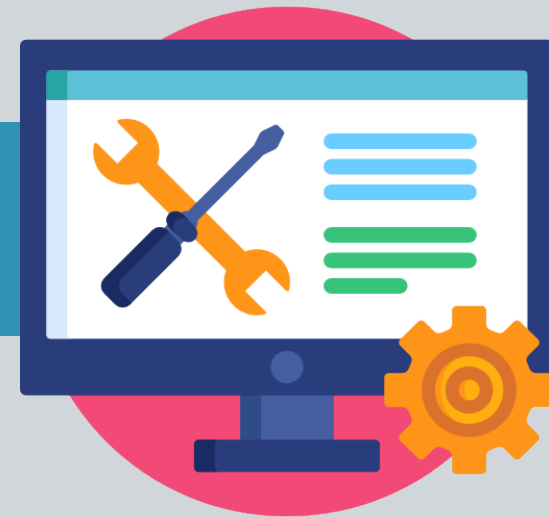
Publish to web:
public portals, open
data initiatives

Secured by organizational Azure AD

Secured by
application
authentication

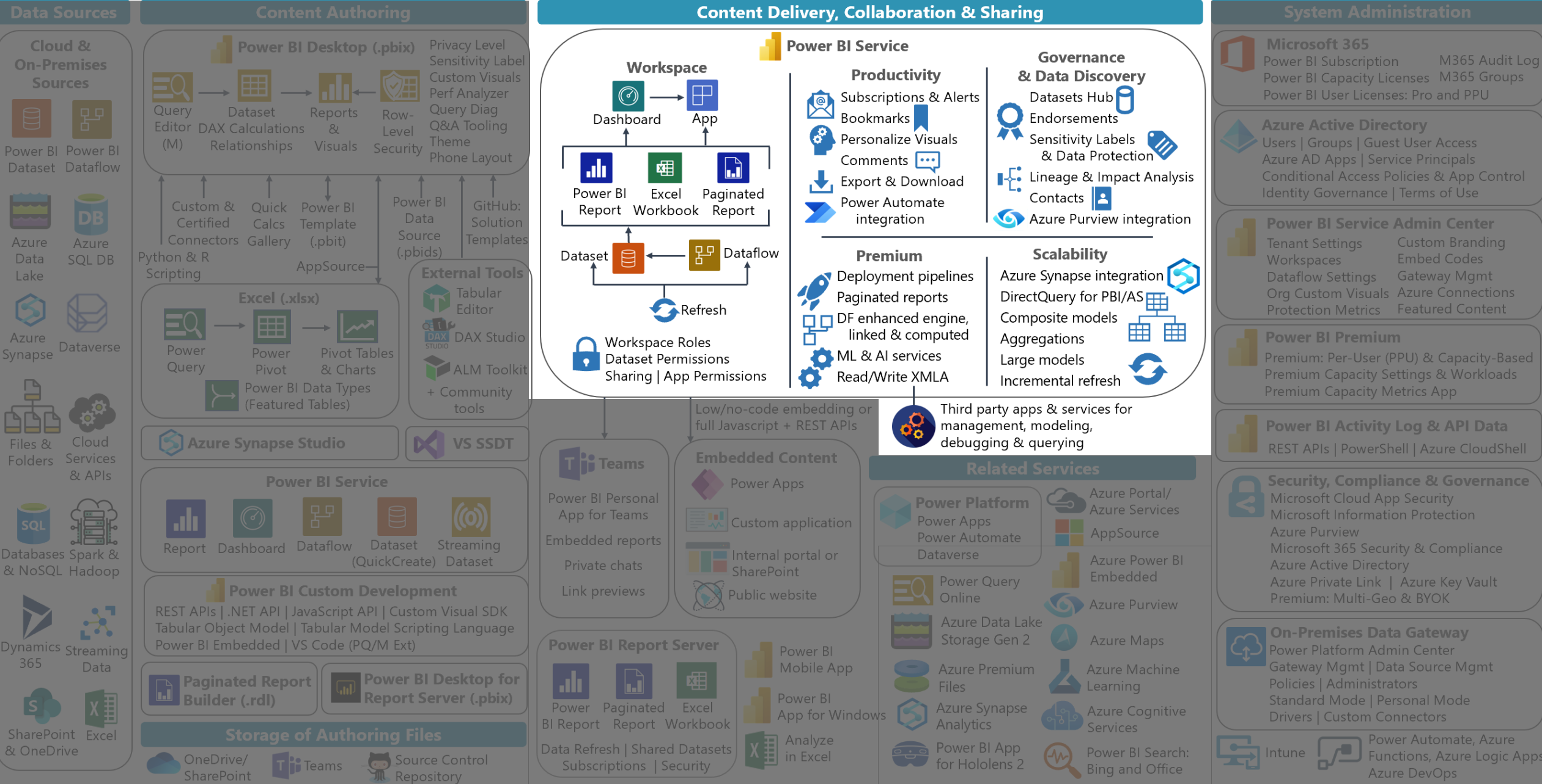
No user
authentication

Using Other Tools



Power BI End-To-End: Top Features, Key Integration Points & Related Services

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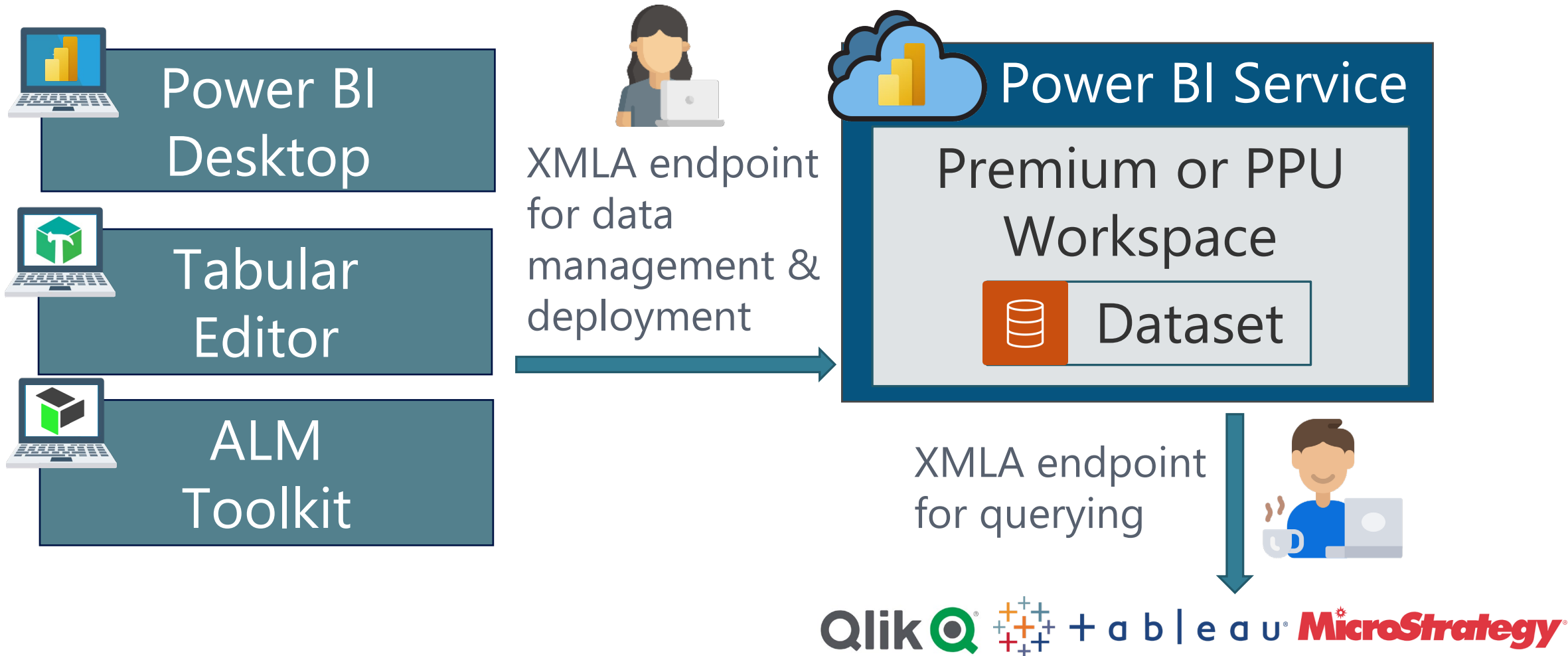
Using the XMLA Endpoint



XMLA = XML for Analysis

An industry standard protocol supported by BI vendors

Interacts with dataset via the Tabular Object Model (TOM)





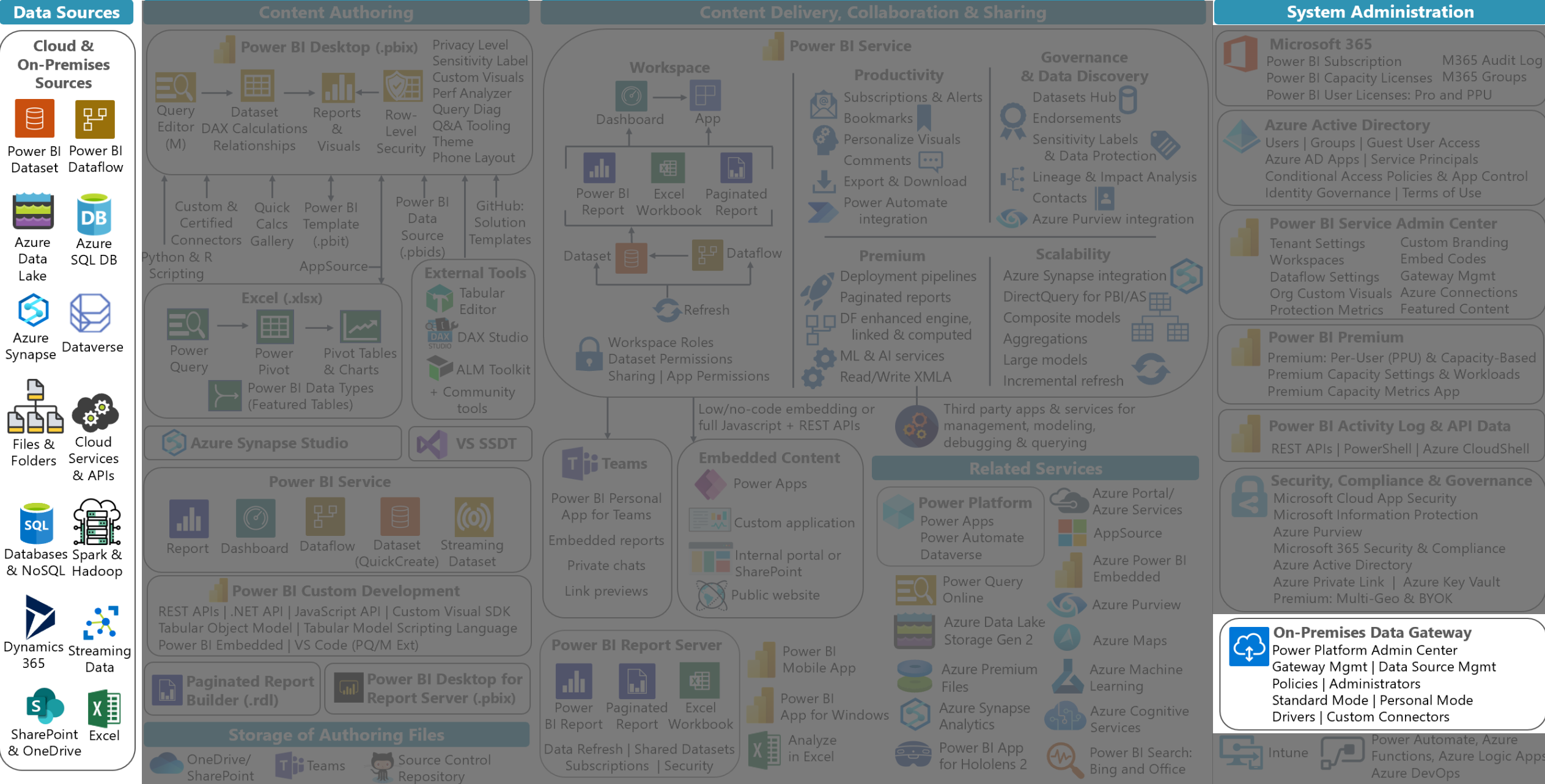
Other Key Components in a Power BI Architecture

On-Premises Data Gateway



Power BI End-To-End: Top Features, Key Integration Points & Related Services

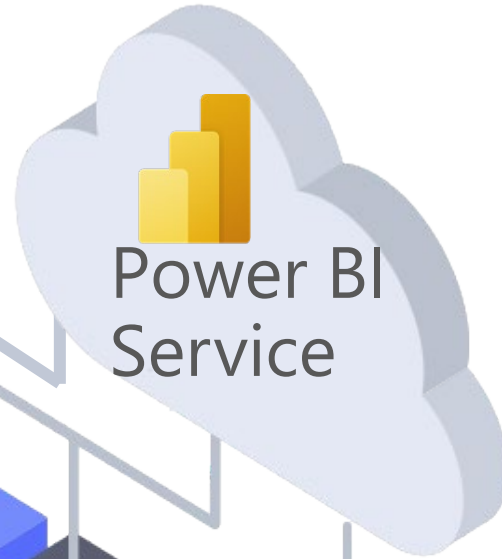
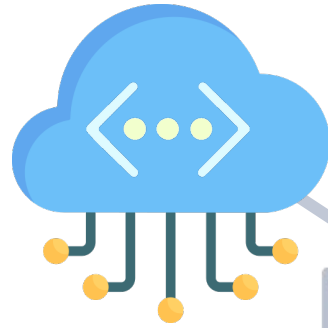
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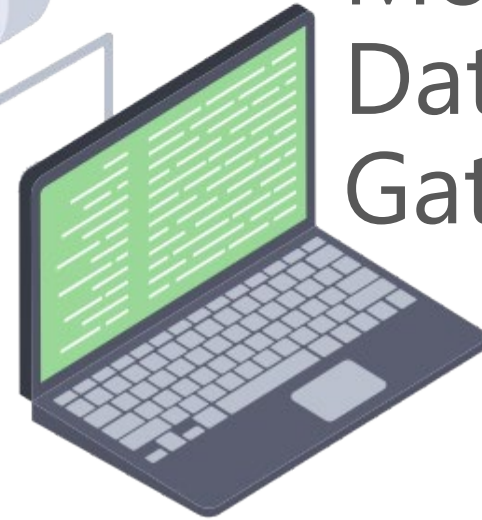
Three Types of Gateways

Virtual Network
Data Gateway

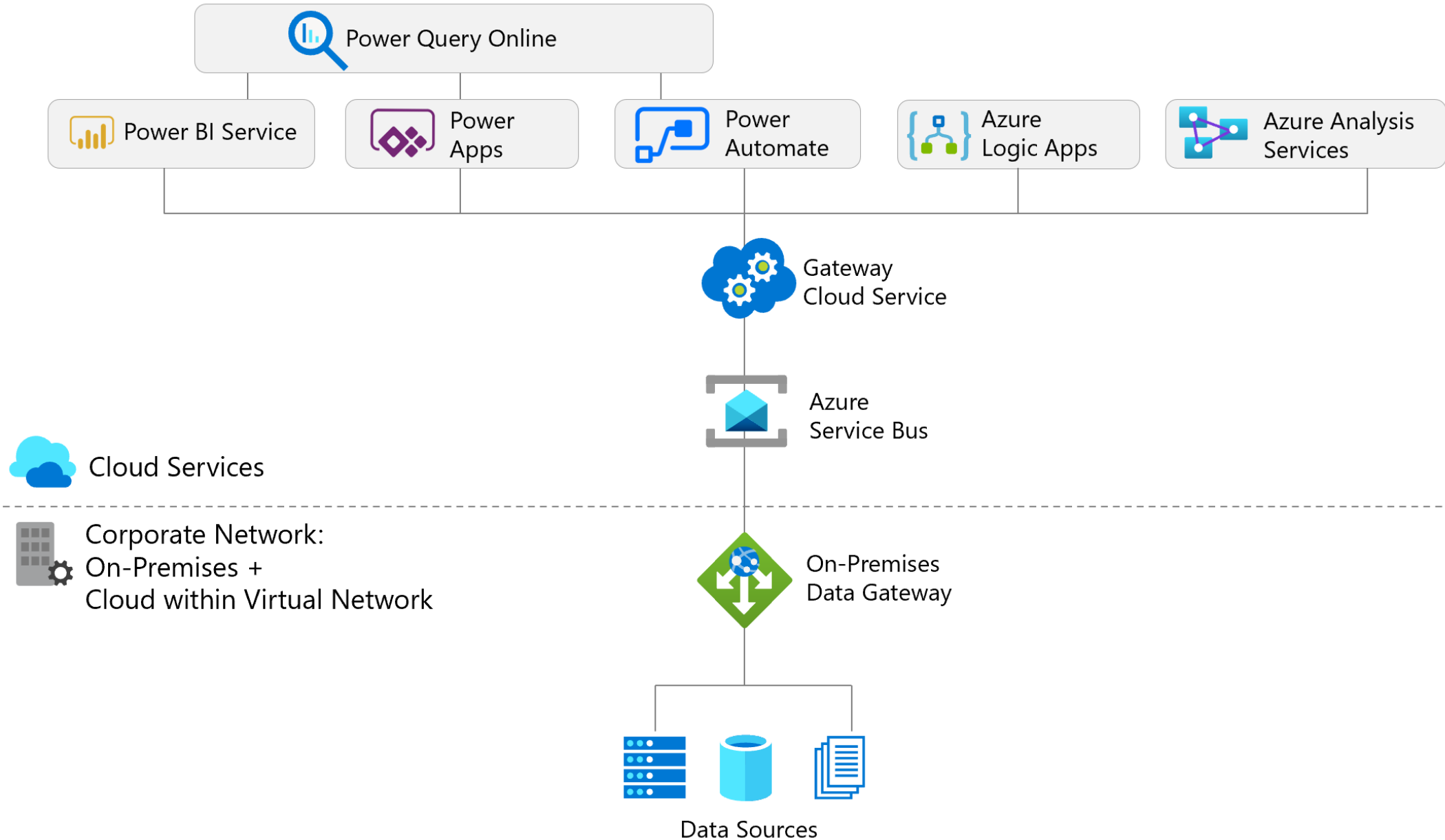


Personal
Mode
Data
Gateway

Standard Mode
Data Gateway Cluster



Standard Mode Data Gateway



Three Types of Gateways



VNet



Standard Mode



Personal Mode

For use by	Many users	Many users	One user
Managed by	Microsoft	Customer (Admin)	Customer (User)
Premium Workspaces	--Yes--	N/A	N/A
Supports:			
Data Refresh	Yes	Yes	Yes
AAD SSO (DQ-PBI dset)	Yes	--No--	--No--
Standard DQ (+src SSO)	Yes	Yes	--No--
Live Connection	Yes	Yes	--No--
R & Python	--No--	--No--	Yes

When is a Gateway Needed?



In the Power BI Service: AND **Data Source Is Located:**

Refreshing imported datasets

Refreshing dataflows

Using DirectQuery

Using Live Connection for Analysis Services

Data center within corporate network or on-premises

Cloud-based virtual machine (IaaS: infrastructure as a service)

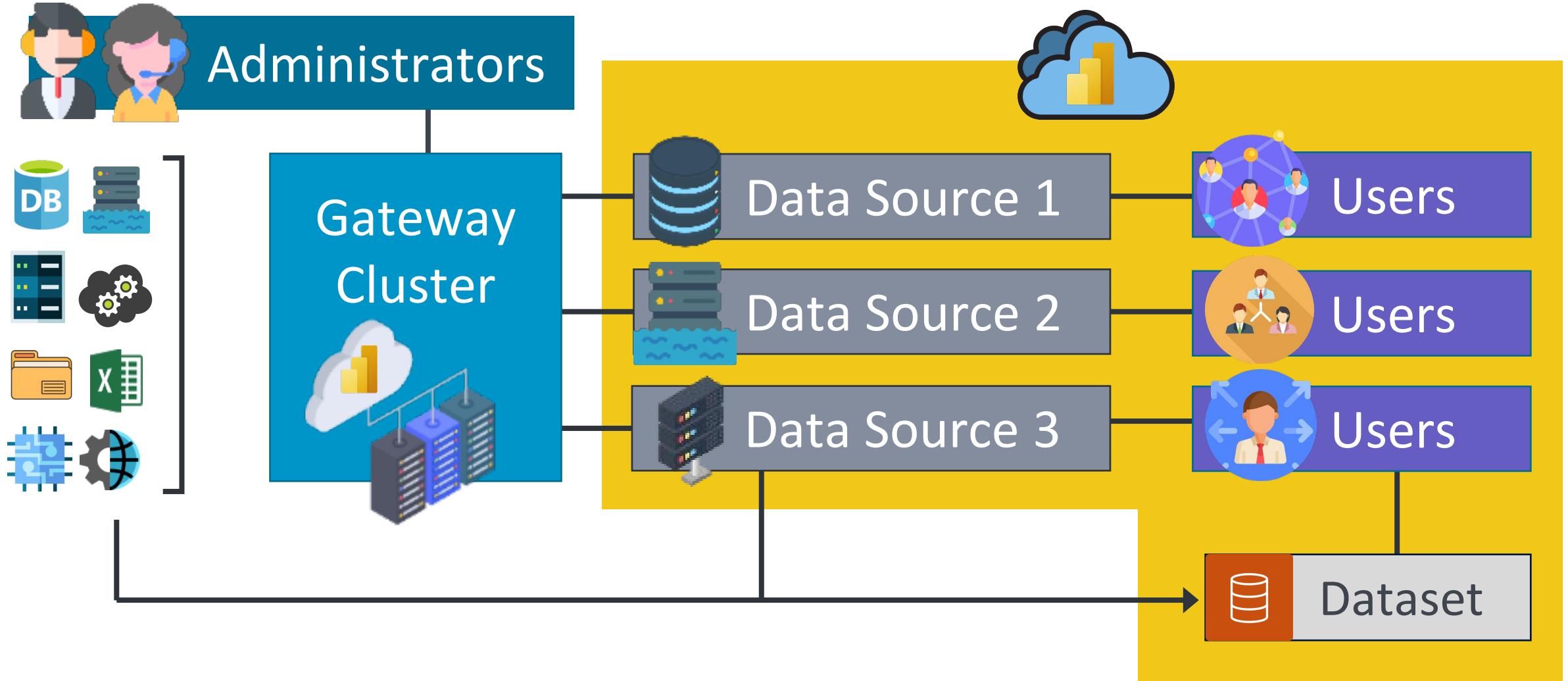
Cloud-based database in a VNet (PaaS: platform as a service in a virtual network)

OR **Certain Functionality is Used:**

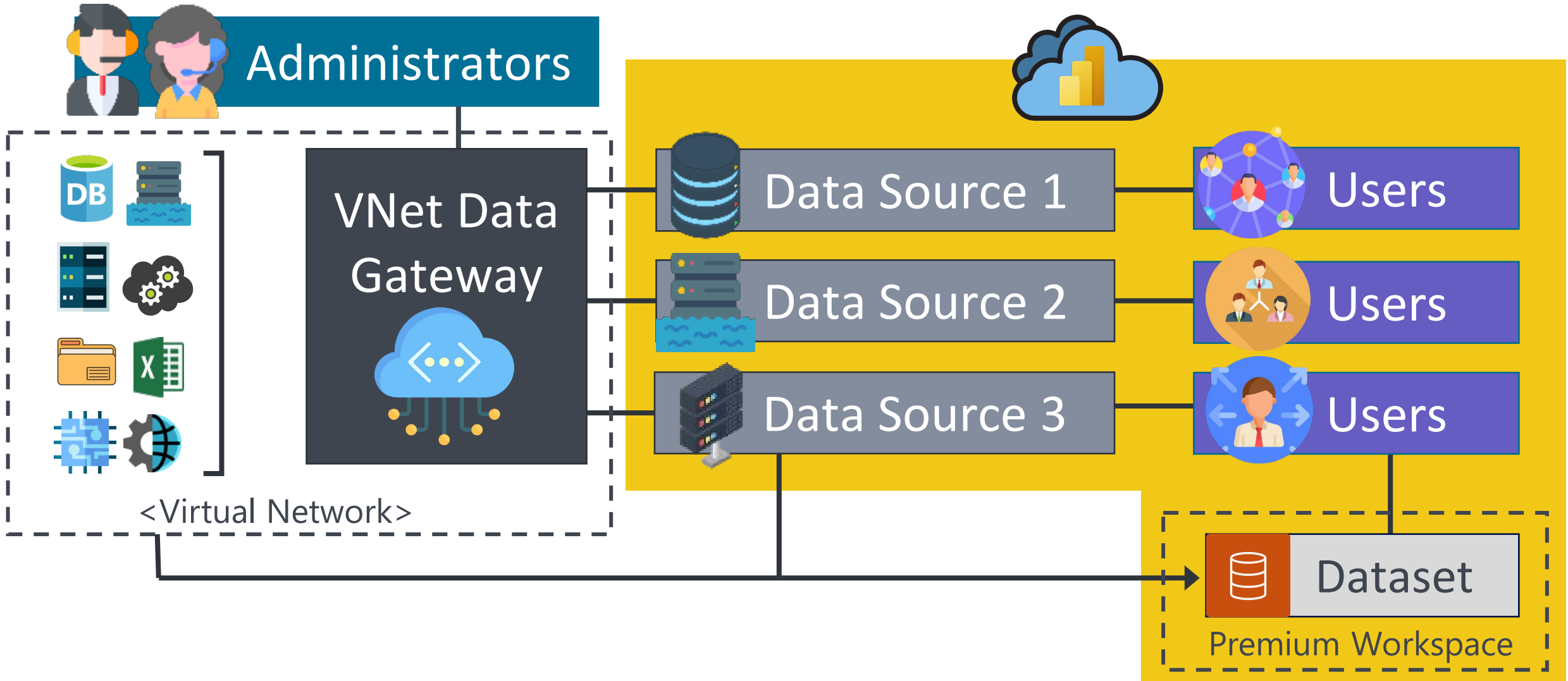
Web.Page() function

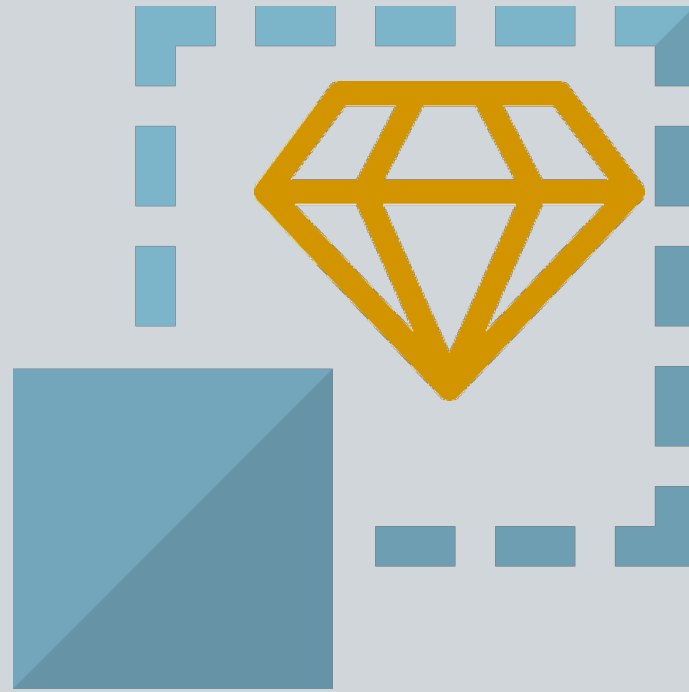
Single M query combines cloud & on-prem data

Standard Mode Data Gateway



Virtual Network Data Gateway

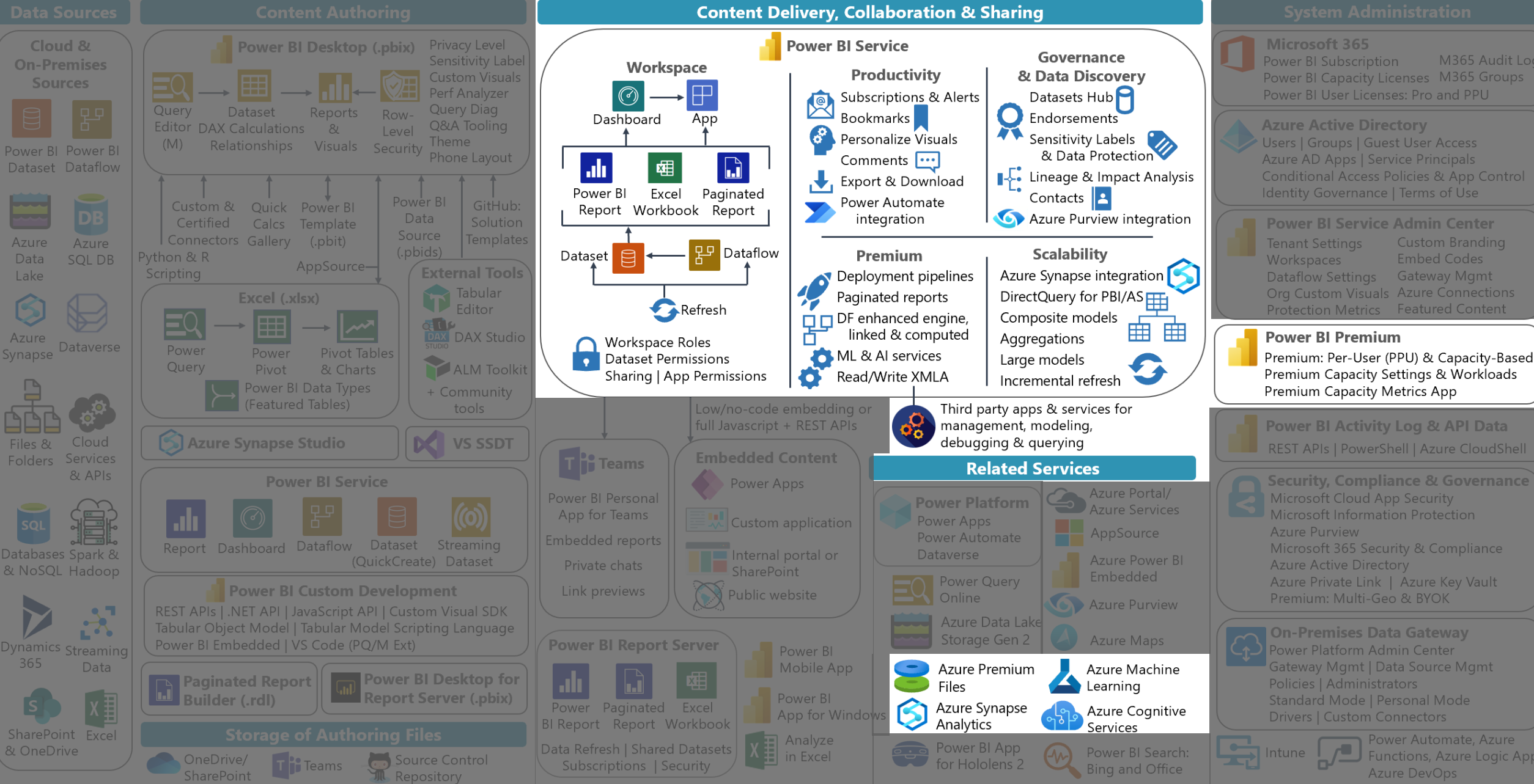




Power BI Premium & Premium Per User

Power BI End-To-End: Top Features, Key Integration Points & Related Services

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4 Workspace Types are Based on Licensing



 User-based named licensing

-  My Workspace
-  Pro Workspace

Power BI Free license

Power BI Pro license

 + User-based Premium licensing

-  PPU Workspace

Premium Per User (PPU) license

 Capacity-based Premium licensing

-  Premium Workspace

Power BI Premium (P or EM) or Power BI Embedded (A SKUs)







Premium Gen 1

Premium Gen 2

Who Can Access a Workspace?



Free User Pro User PPU User

		Free User	Pro User	PPU User
	 User-based named licensing	 My Workspace	X	X
		 Pro Workspace		X
Premium Gen 2	 User-based Premium licensing			X
	 Capacity-based Premium licensing	 Premium Workspace	X	X

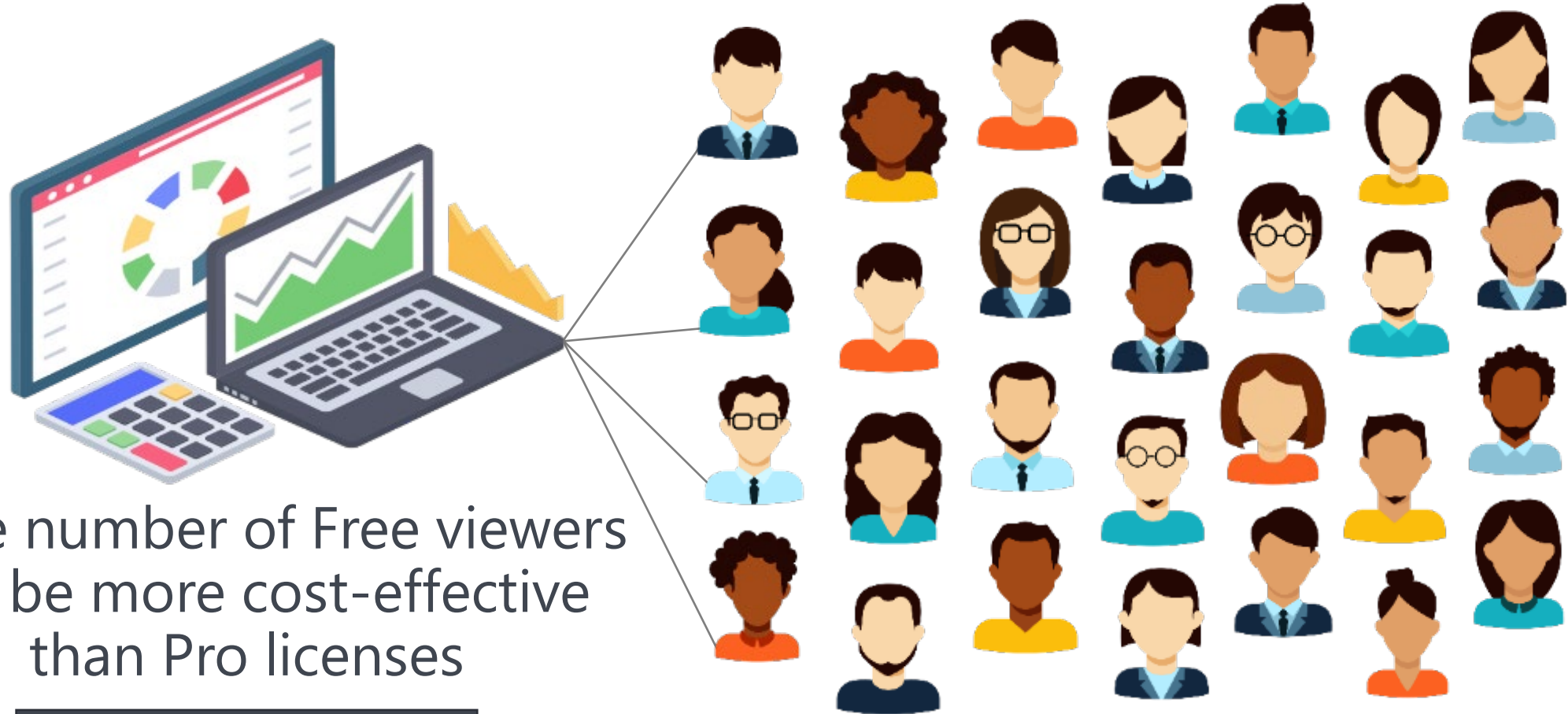
Premium Gen 1

Premium Gen 2

Top Reasons for Using Power BI Premium



Unlimited Content Distribution to Free Users



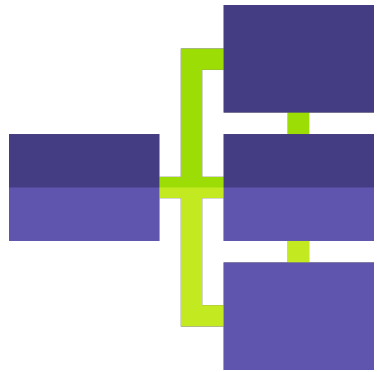
Large number of Free viewers
can be more cost-effective
than Pro licenses

Not available with PPU

Top Reasons for Using Power BI Premium



Features to Bring Enterprise BI Capabilities to Self-Service BI



Deployment pipelines



Full featureset for dataflows



XMLA endpoint read/write



Near real-time reporting: change detection with automatic page refresh



Paginated reports in the Power BI Service

Top Reasons for Using Power BI Premium



Integration with Azure Apps



Azure Cognitive
Services



Azure Machine
Learning

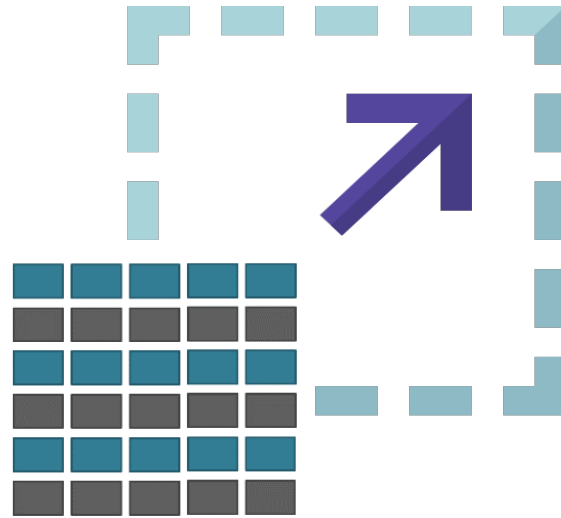
Top Reasons for Using Power BI Premium



Scalability

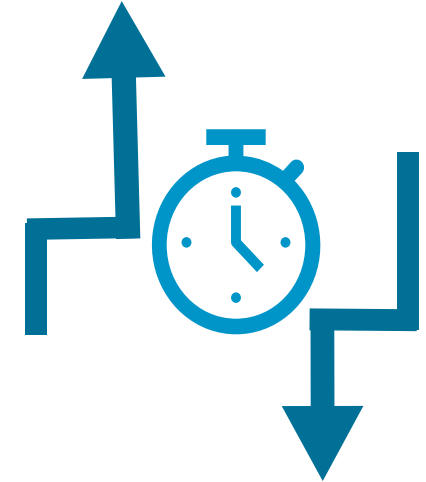


More frequent data refreshes



Large datasets

Up to 100GB if PPU;
400GB if Premium



Auto-scale v-cores for 24 hours to handle occasional bursts of traffic

Gen 2 only

Top Reasons for Using Power BI Premium



Regulatory & Privacy Concerns



Bring-your-own encryption key (BYOK) with Azure Key Vault

Available with PPU only if the entire tenant is BYOK



Data sovereignty: specific geography for data storage

Not available with PPU

Top Reasons for Using Power BI Premium



Hybrid Cloud



Use of Power BI Report Server as an alternative report portal

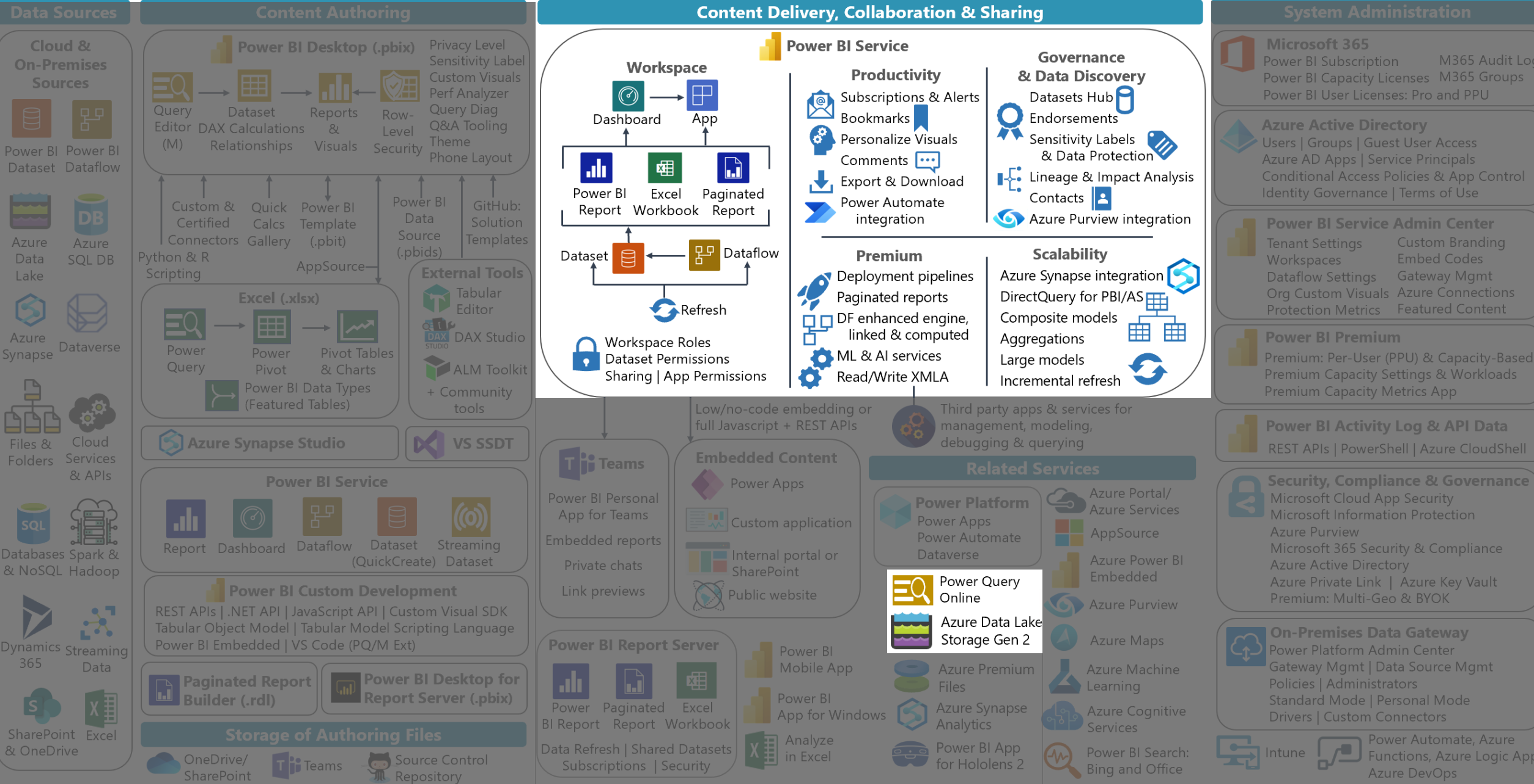
Not available with PPU



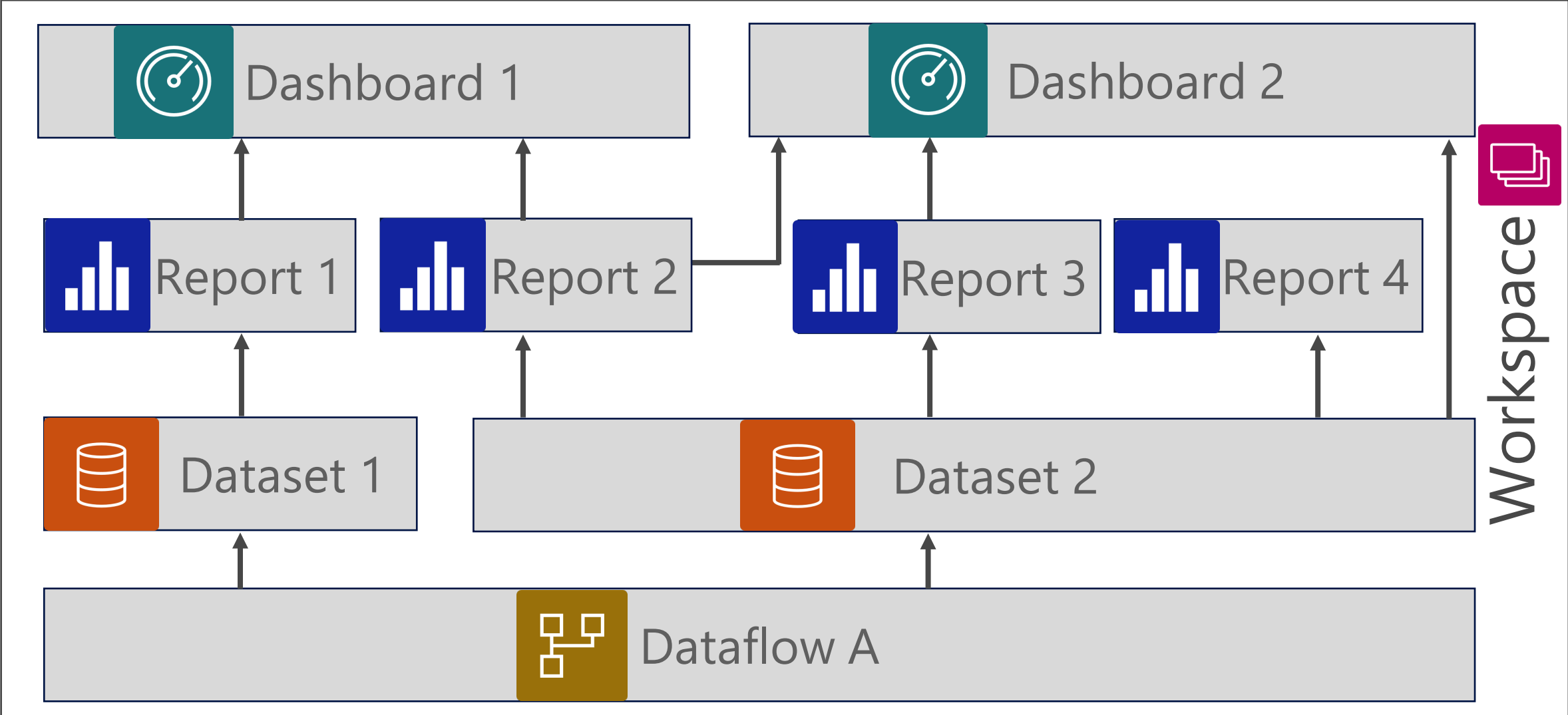
Power BI Dataflows

Power BI End-To-End: Top Features, Key Integration Points & Related Services

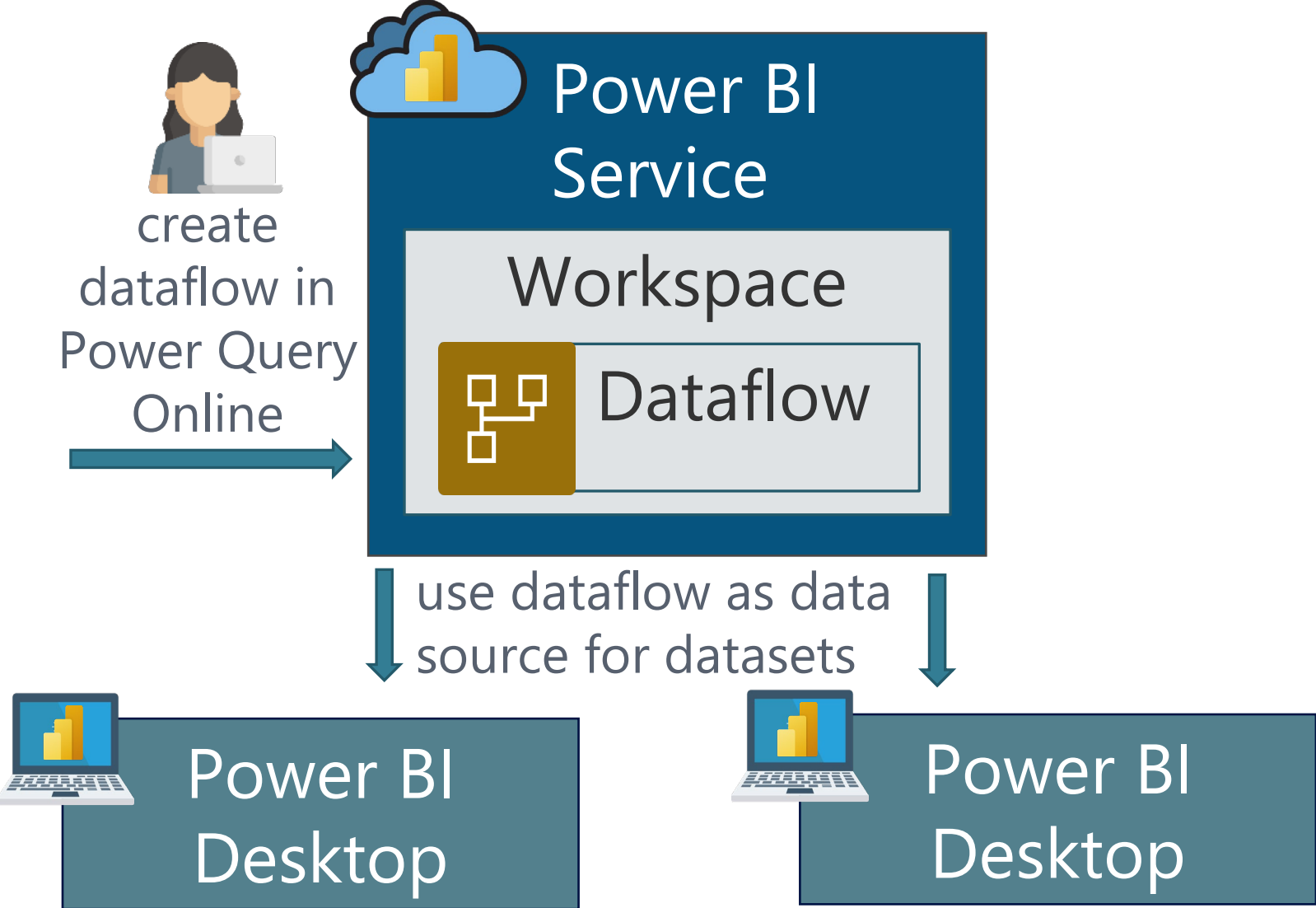
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Dataflows in the Power BI Service



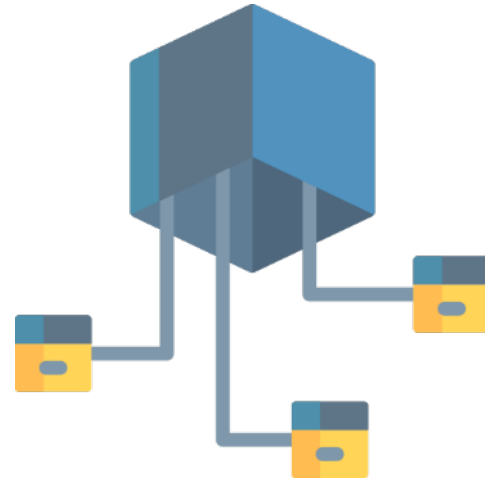
Dataflows



Top Reasons for Using Power BI Dataflows



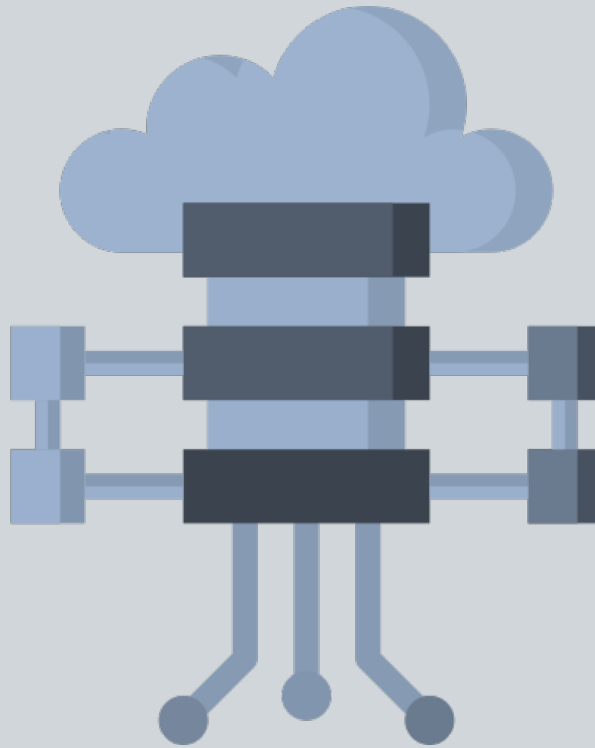
Reusable self-service data cleansing & preparation reduces repetitive work by data modelers



Standardized, consistent data consumed by many different datasets



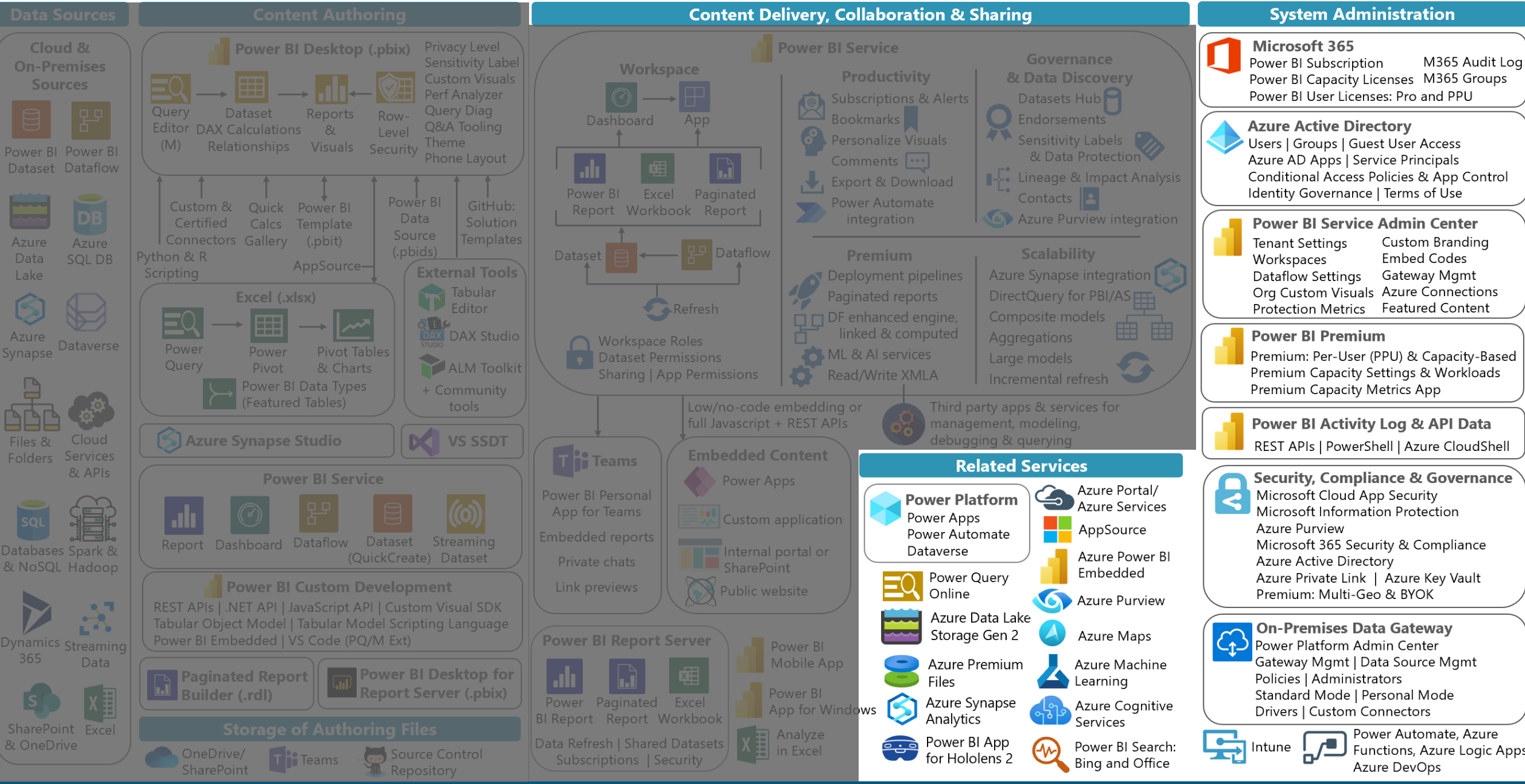
Reduce load & queries sent to source systems



Other Components

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Integration with Microsoft 365



 M365 Audit Log → Power BI Activity Log

 User licenses & Power BI Premium licenses

 OneDrive for Business and SharePoint

 Teams

Integration with Power Platform



Power Automate (Flow)

Power Apps

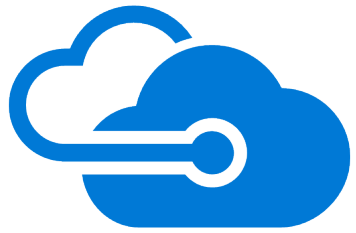
Common Data Service

Common Data Model

Power Platform Admin Center



Integration with Azure Services



Azure Active Directory:

Users, Groups, AAD Apps, Service Principals, B2B



Power BI Embedded (A-series SKUs)



Azure Data Lake Storage Gen 2 (dataflows storage)



Azure Premium Files (large dataset storage)



Azure Cognitive Services



Azure Machine Learning



Azure Synapse Analytics



Azure Purview

Integration with Azure Security & Governance Services



Microsoft Cloud App Security



Microsoft Information Protection



Azure Key Vault



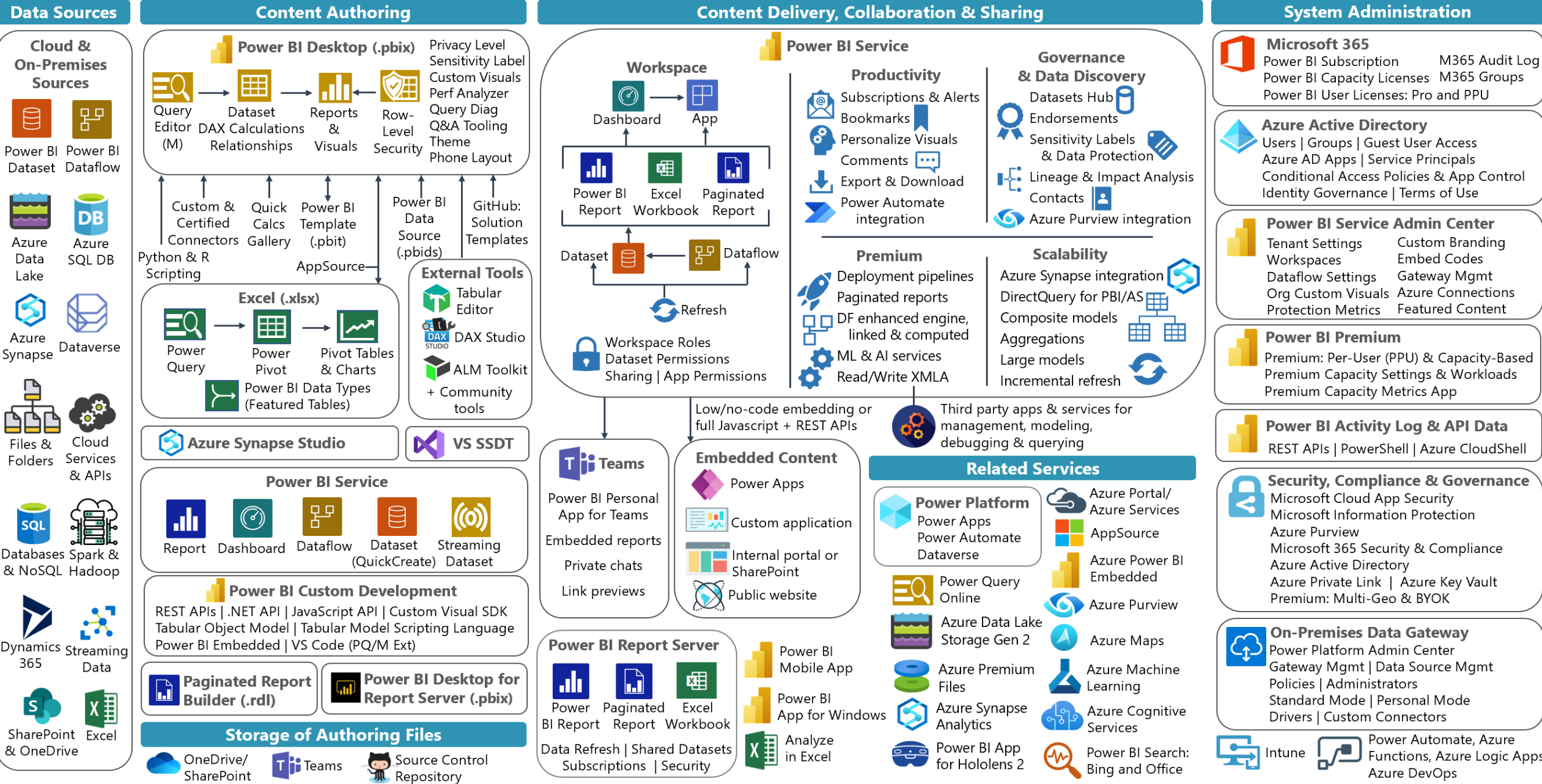
Intune (mobile app management)



Wrap-Up,
Q&A,
Links to More Info

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Q&A

More Information from Melissa Coates



Slides:

CoatesDS.com/Presentations



Diagrams:

CoatesDS.com/Diagrams



Power BI Governance Training:

CoatesDS.com/Training



Blog:

CoatesDS.com/Blog-Posts



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