



Power BI Architecture End-to-End

Melissa Coates

Data Architect | Consultant | Trainer

CoatesDataStrategies.com

@SQLChick | @CoatesDS



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



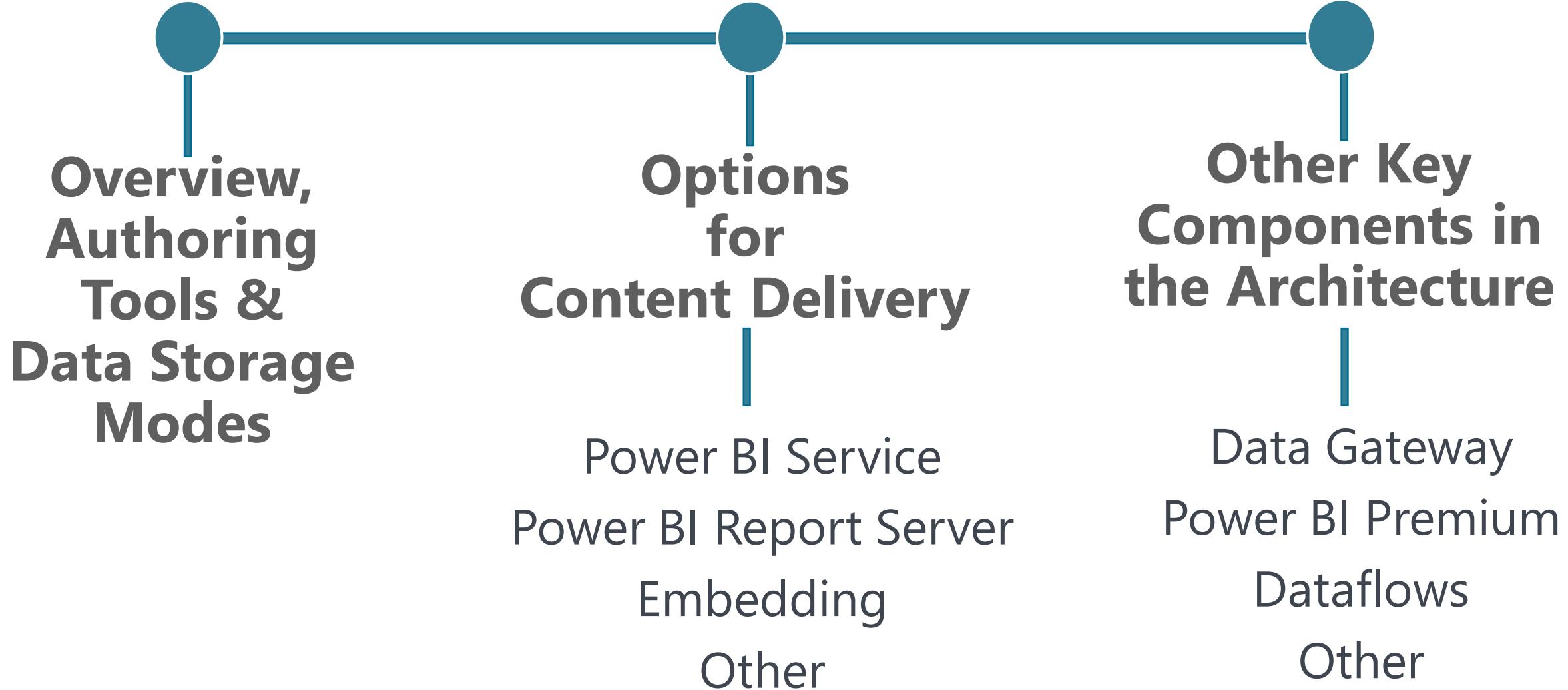
Governance
Adoption & data culture
Center of Excellence
Data architecture
Content management
Data trustworthiness
Security & protection
System oversight

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:

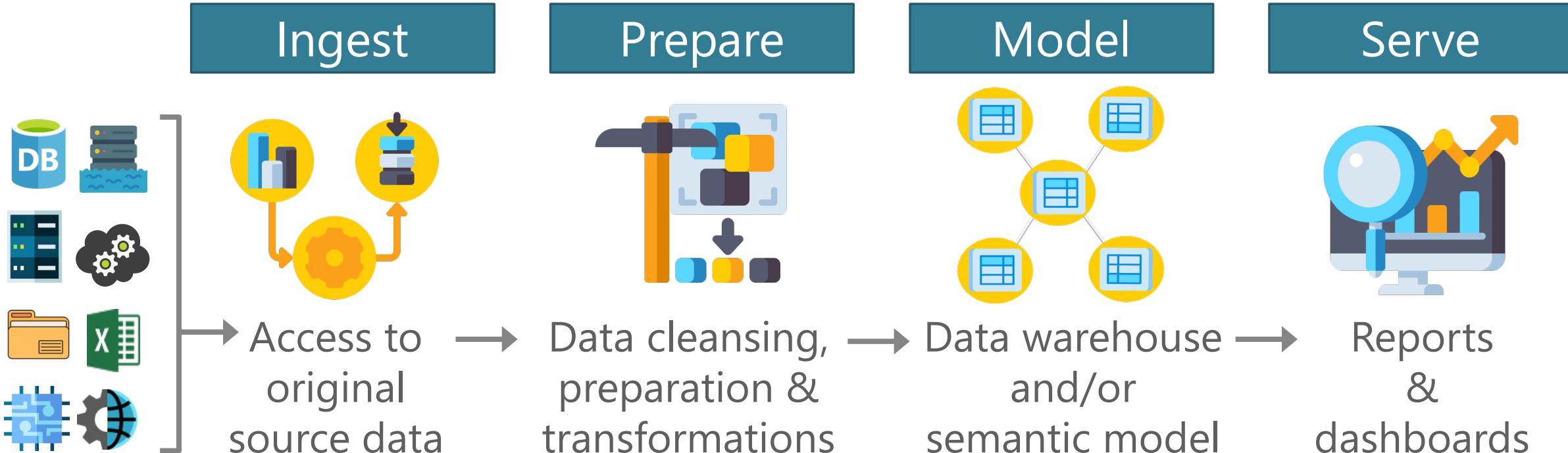
- Data acquisition
- Data preparation & cleansing
- Data modeling
- Calculations
- Reports & visuals
- Content delivery & viewing



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



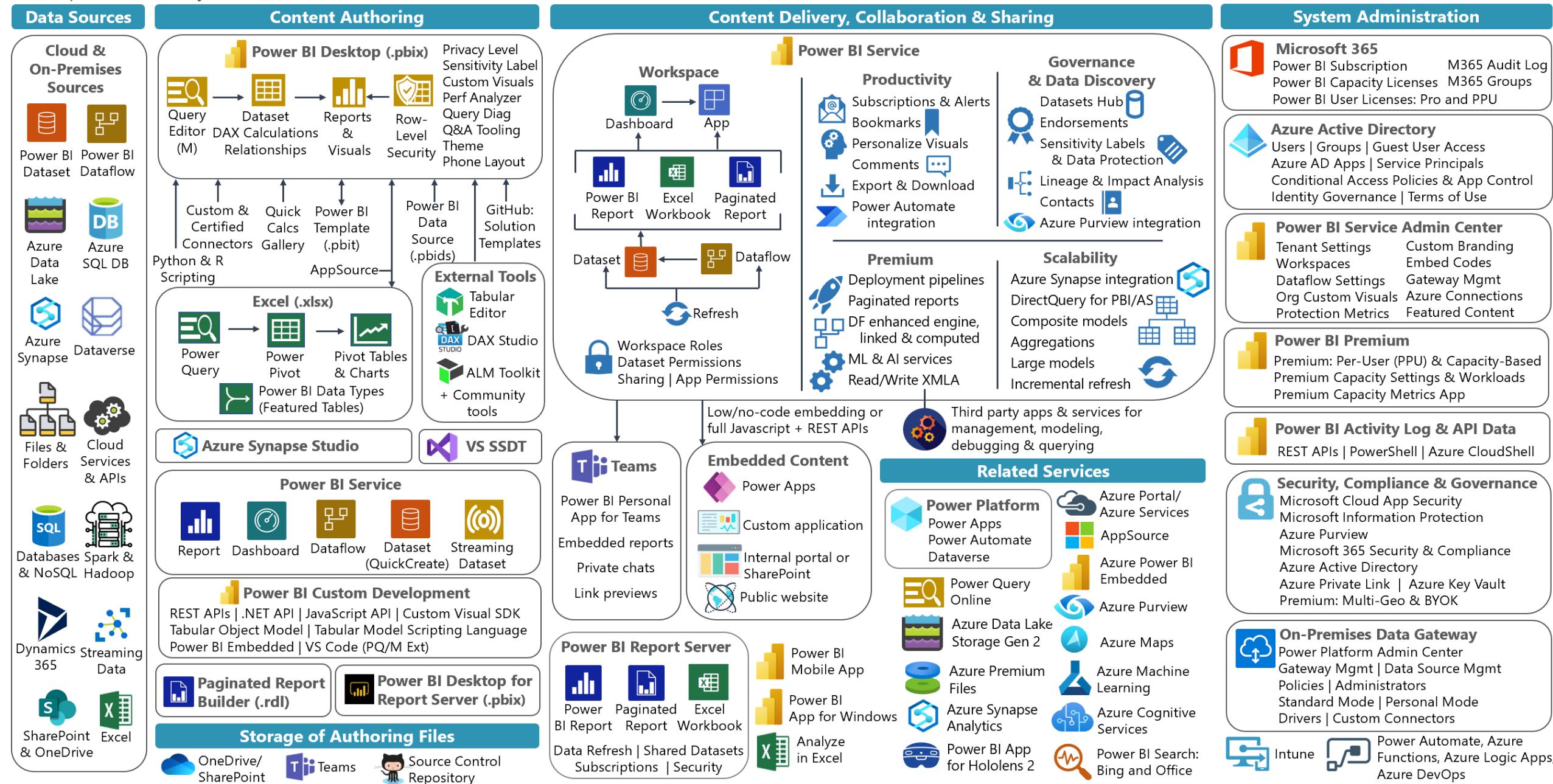
Data Architecture Components



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

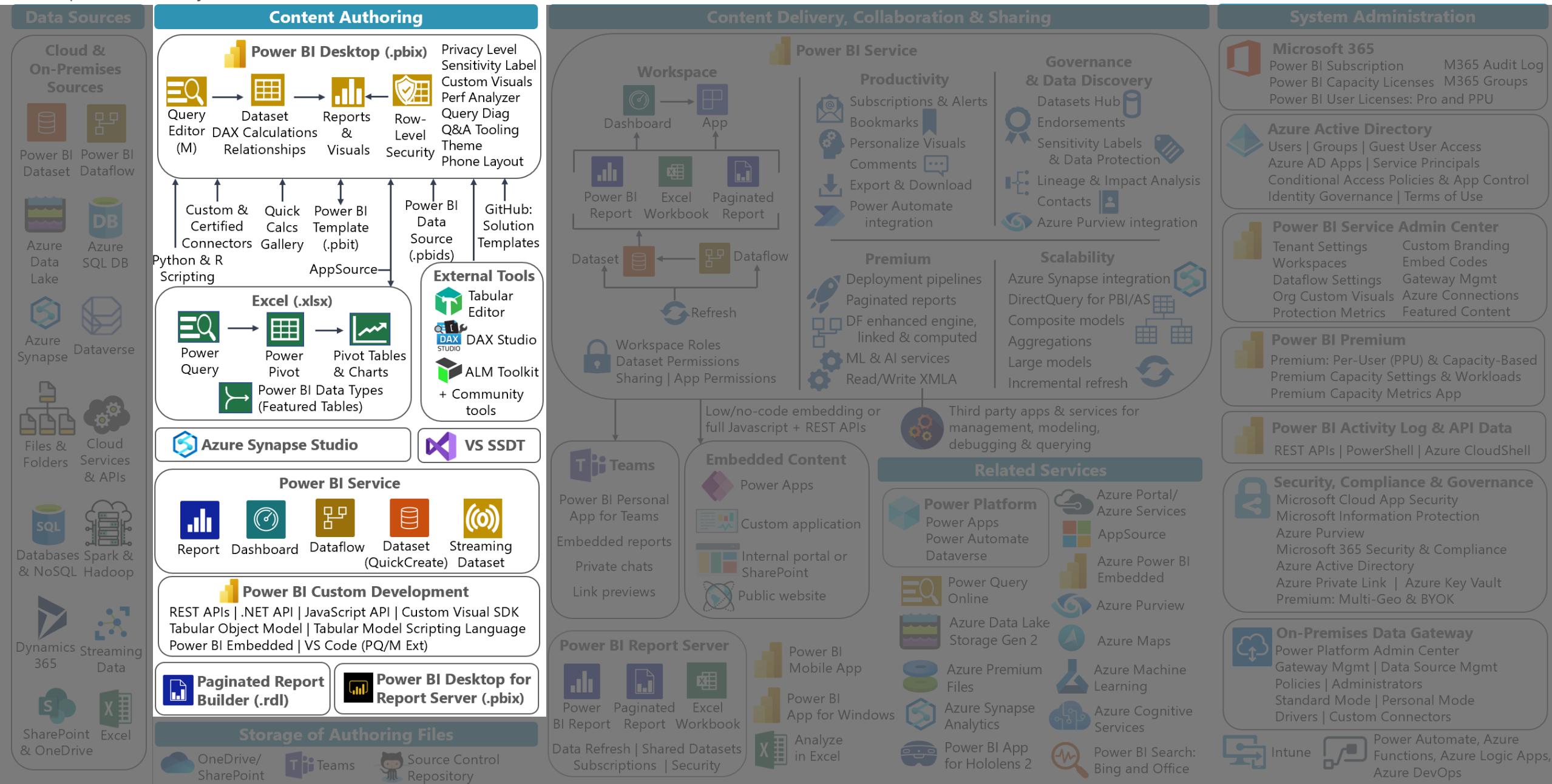


Authoring Tools



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

Last Updated: January 4, 2021





Power BI Authoring



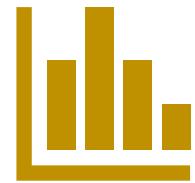
Source
Data



Query
Editor



Data
Calculations
Relationships



Reports &
Visuals

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

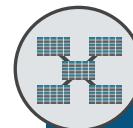
	Local model	Remote model
Data stored in Power BI	Import Mode A PBIX file which contains both the schema & the data	Live Connection Mode A PBIX file with reports that obtain data by querying a Power BI shared dataset
Data remains in source	DirectQuery Mode A PBIX file which contains a model that is schema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



Using a Shared Dataset w/ Live Connection



Shared dataset:



Sales Analysis
Dataset



Reports:



YTD Sales
Revenue



Daily Sales
Targets



Sales by
Product



MoM
Sales
Trends

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



Extending & Customizing a Shared Dataset

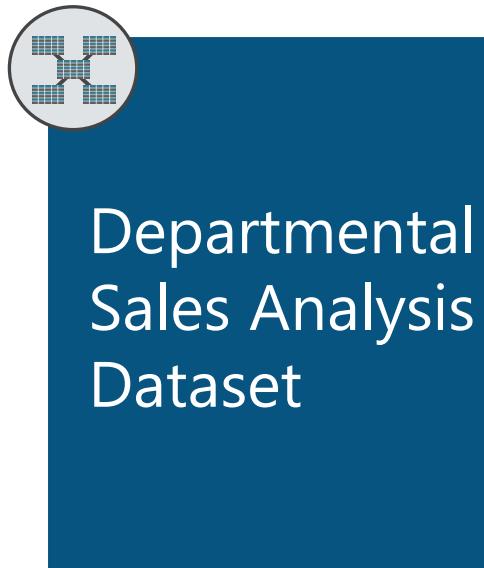
DirectQuery for Power BI Datasets and Azure Analysis Services



Shared
dataset:



Composite
model:



Organizational
Sales Analysis Dataset

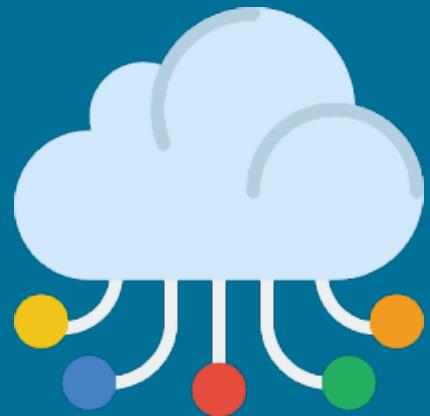
Live Connection is converted to a DirectQuery connection

Organizational data:
DirectQuery to remote model

Departmental data:
Local model



Customize & extend organizational model
with additional data sources & calculations



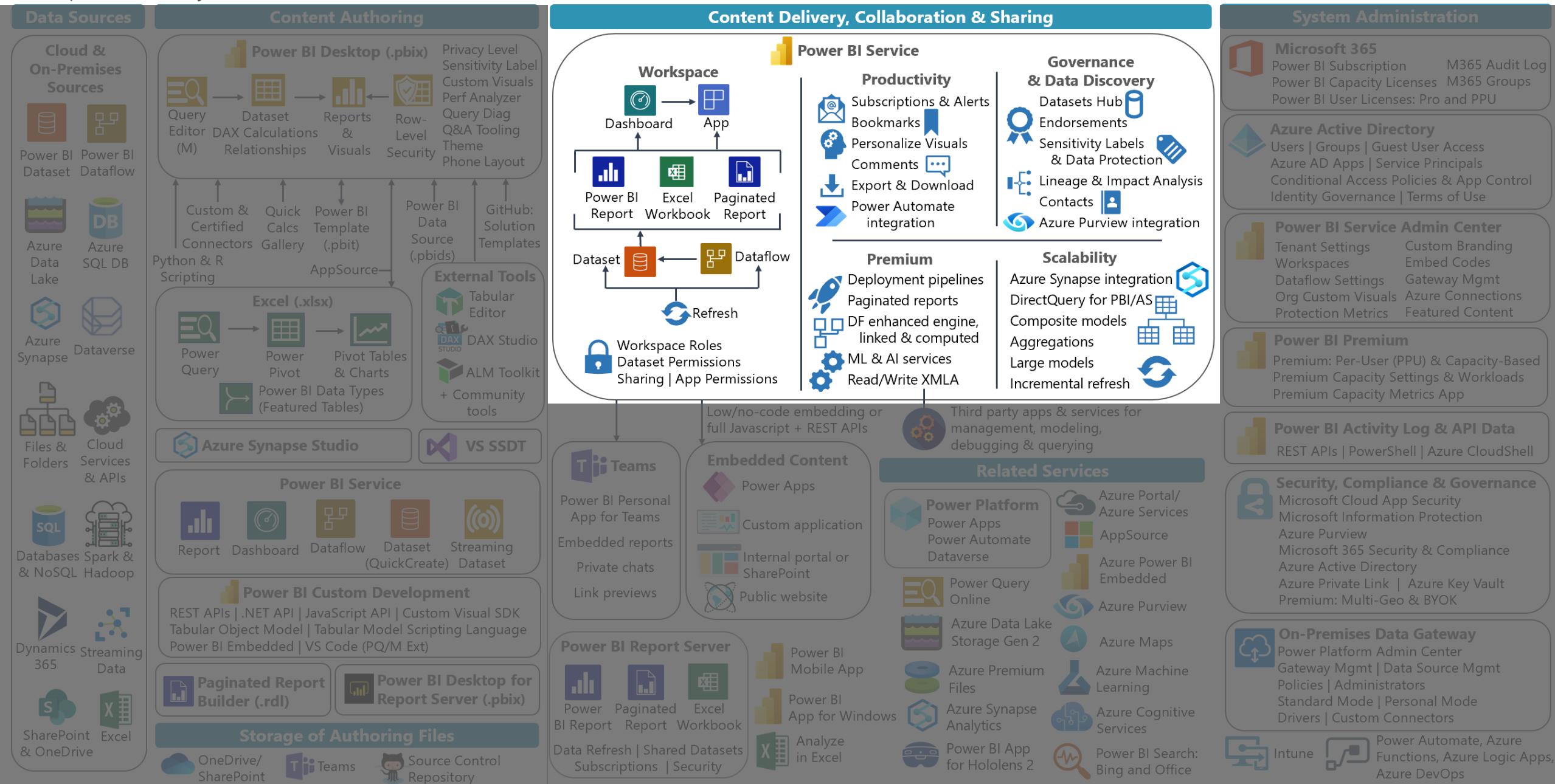
Options for Content Delivery with Power BI



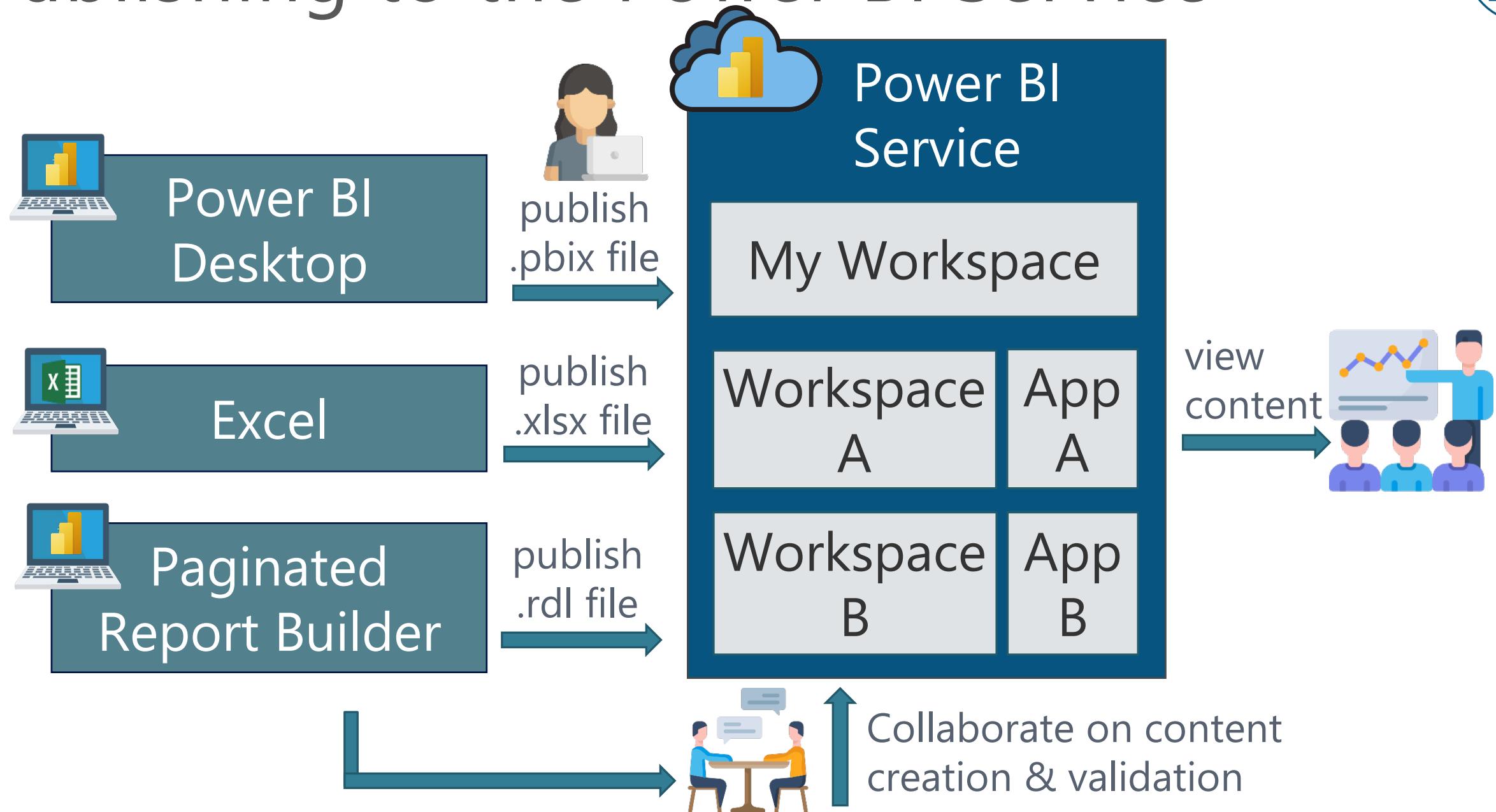
Power BI Service

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

Last Updated: January 4, 2021



Publishing to the Power BI Service



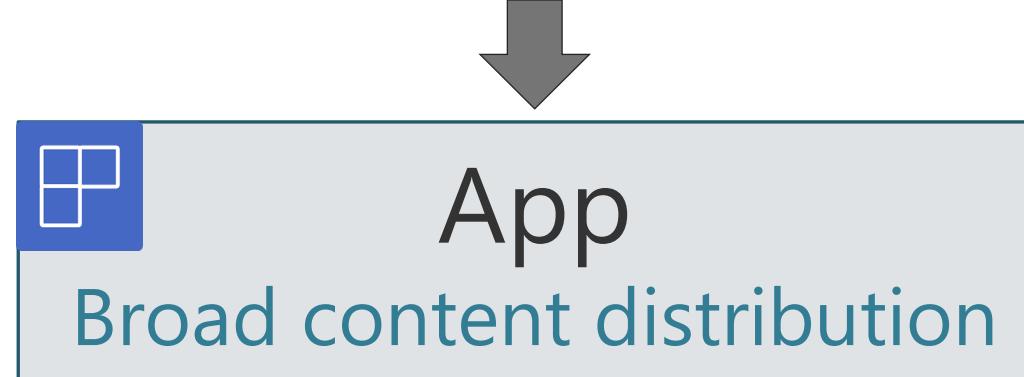
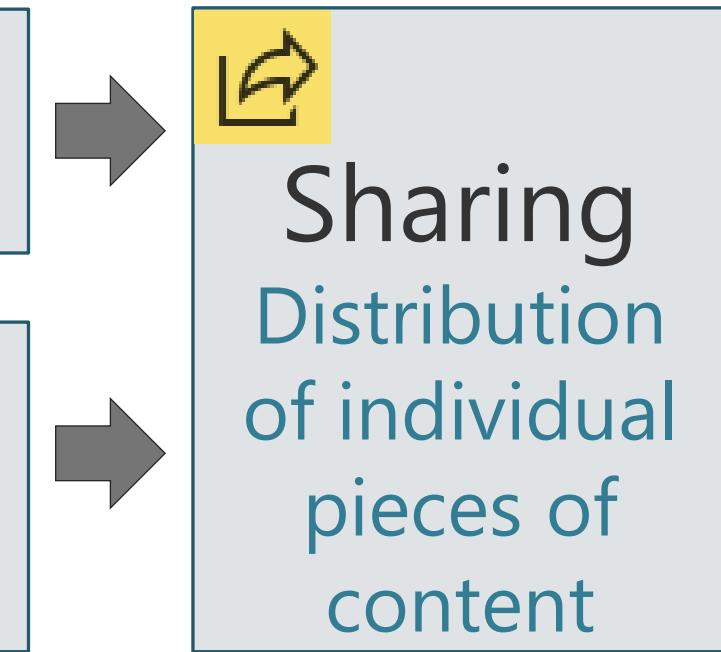
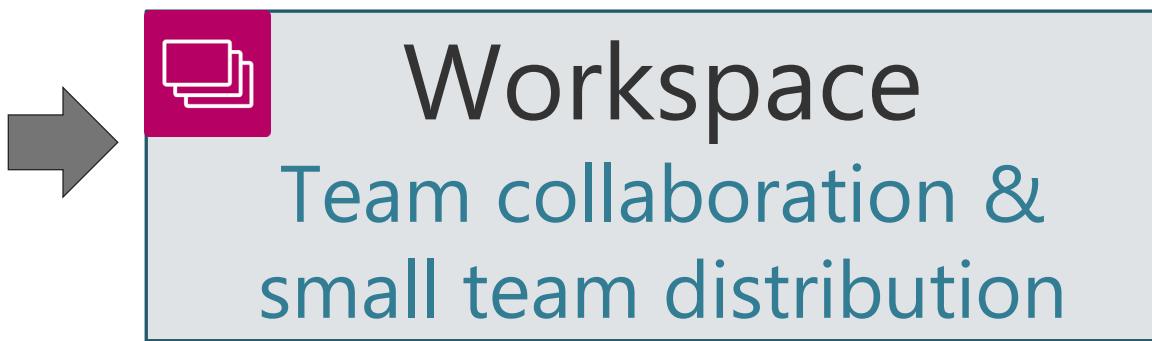
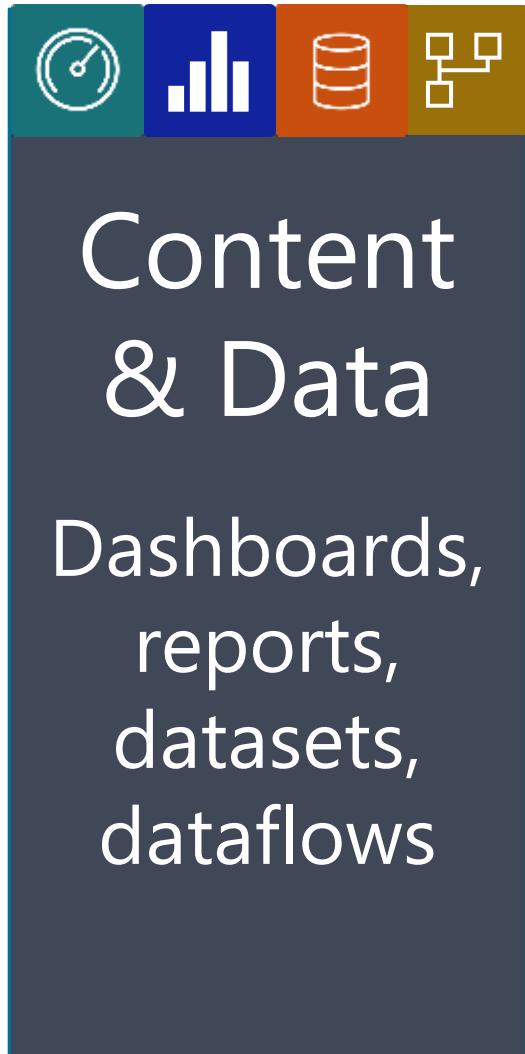


Storing Content in the Power BI Service



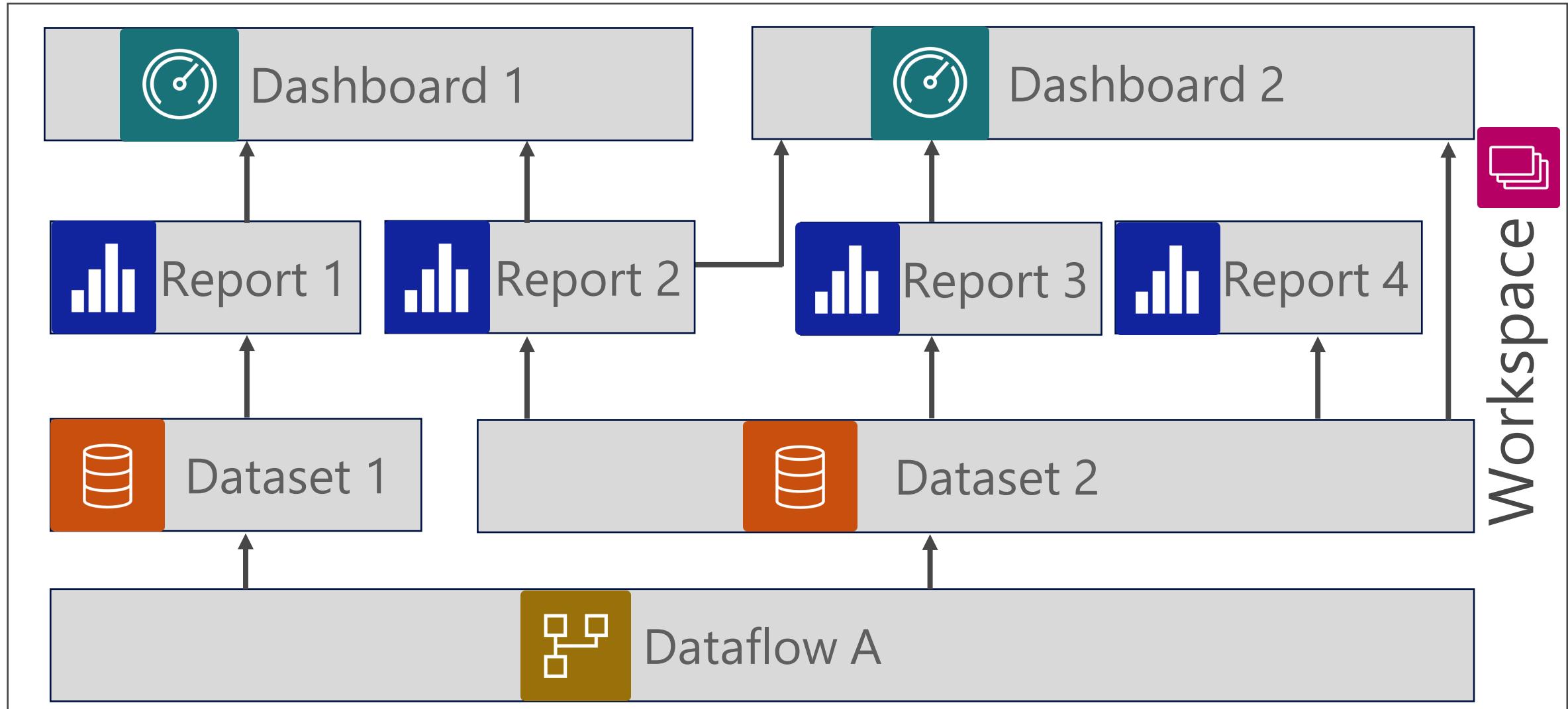


Viewing Content in the Power BI Service





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*):

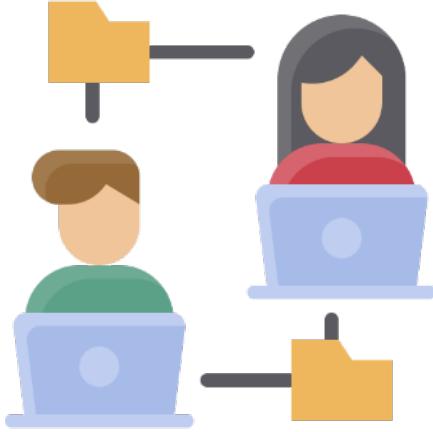
Premium

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

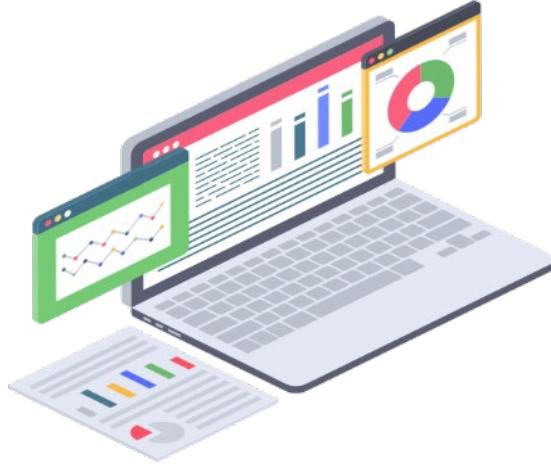


Multiple methods & security options to collaborate with both internal and external users based on Azure Active Directory

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

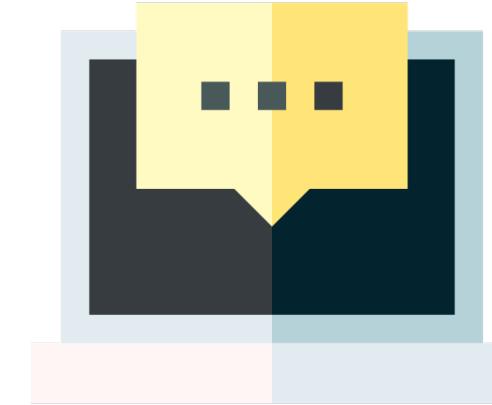
Collaboration, Sharing & Content Distribution



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

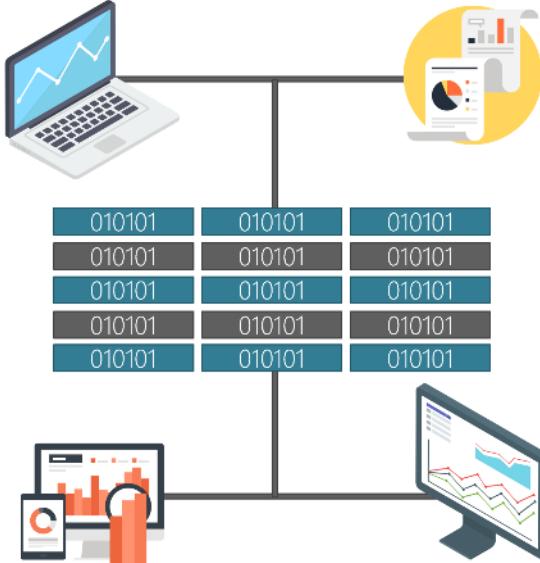


Integration with
Power Automate
& Power Apps

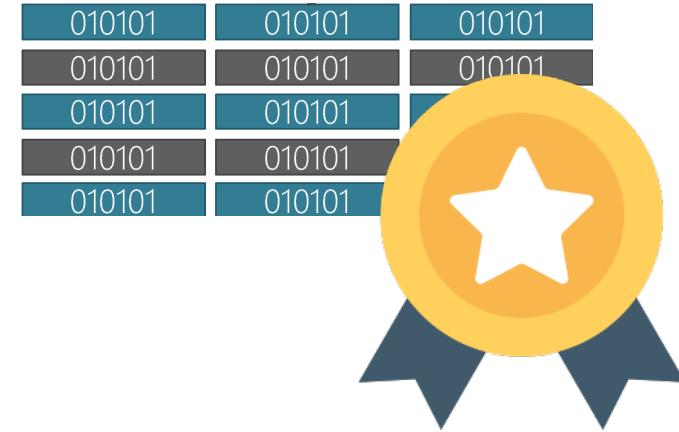


Top Reasons for Using the Power BI Service

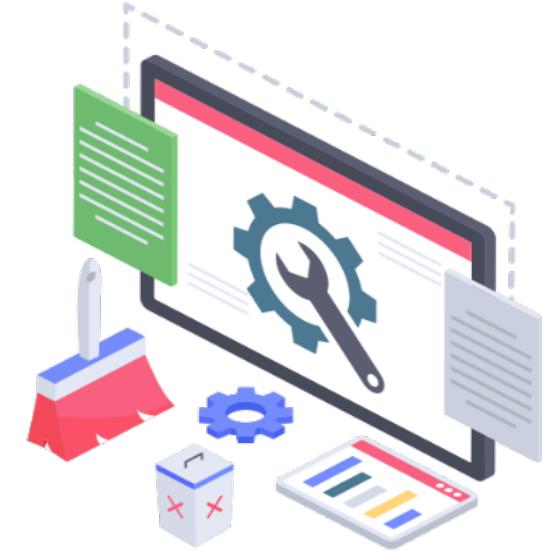
Centralization & Reusability



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



Certified & promoted
(endorsements) for
datasets & dataflows

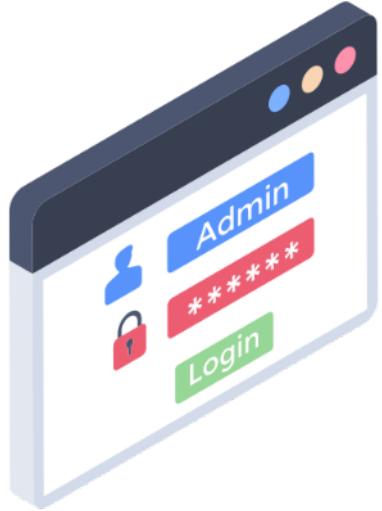


Centralized data
cleansing with Power
BI dataflows



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



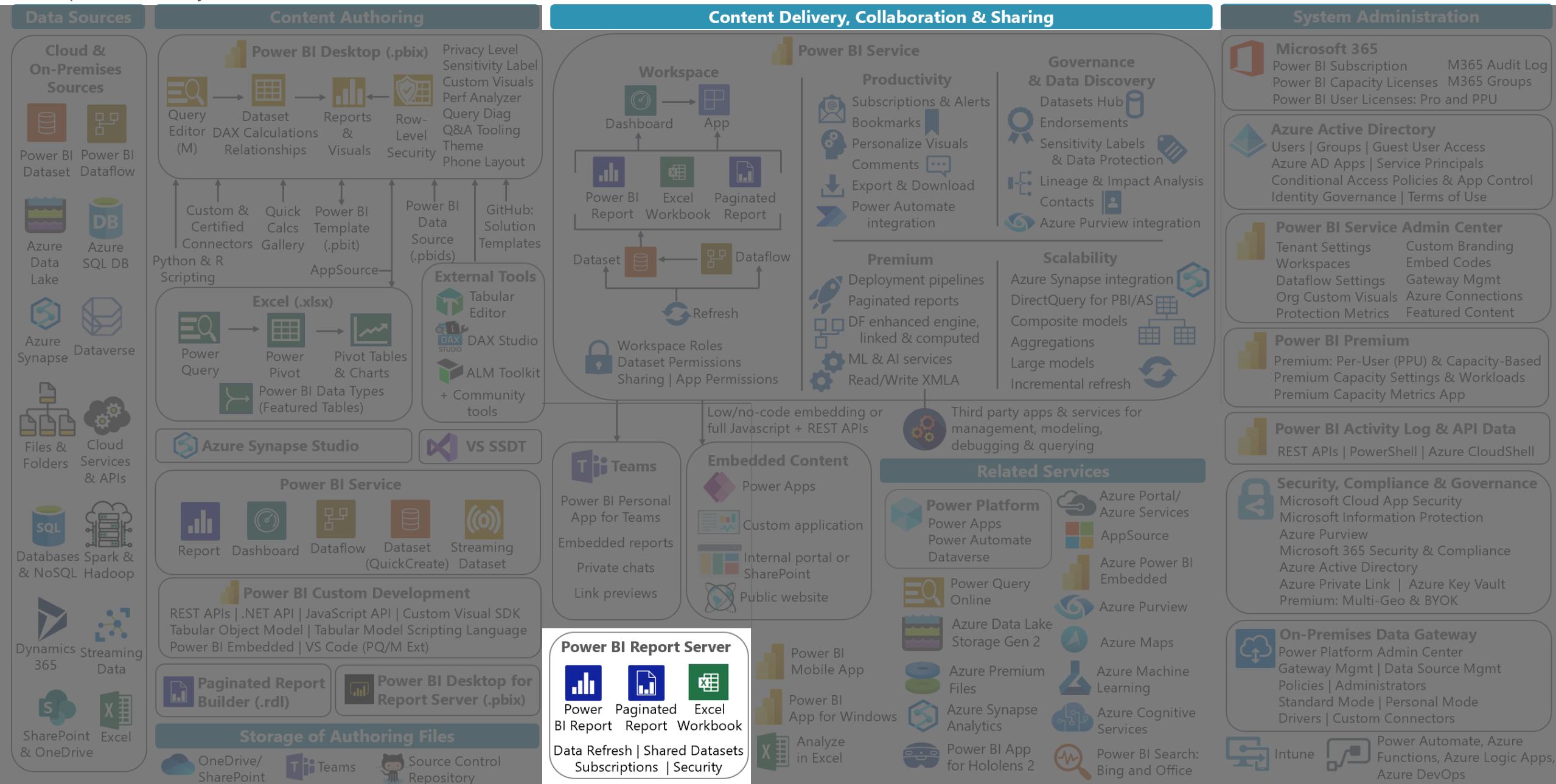
Integration with Microsoft
Cloud App Security to
implement data loss
prevention policies

Power BI Report Server



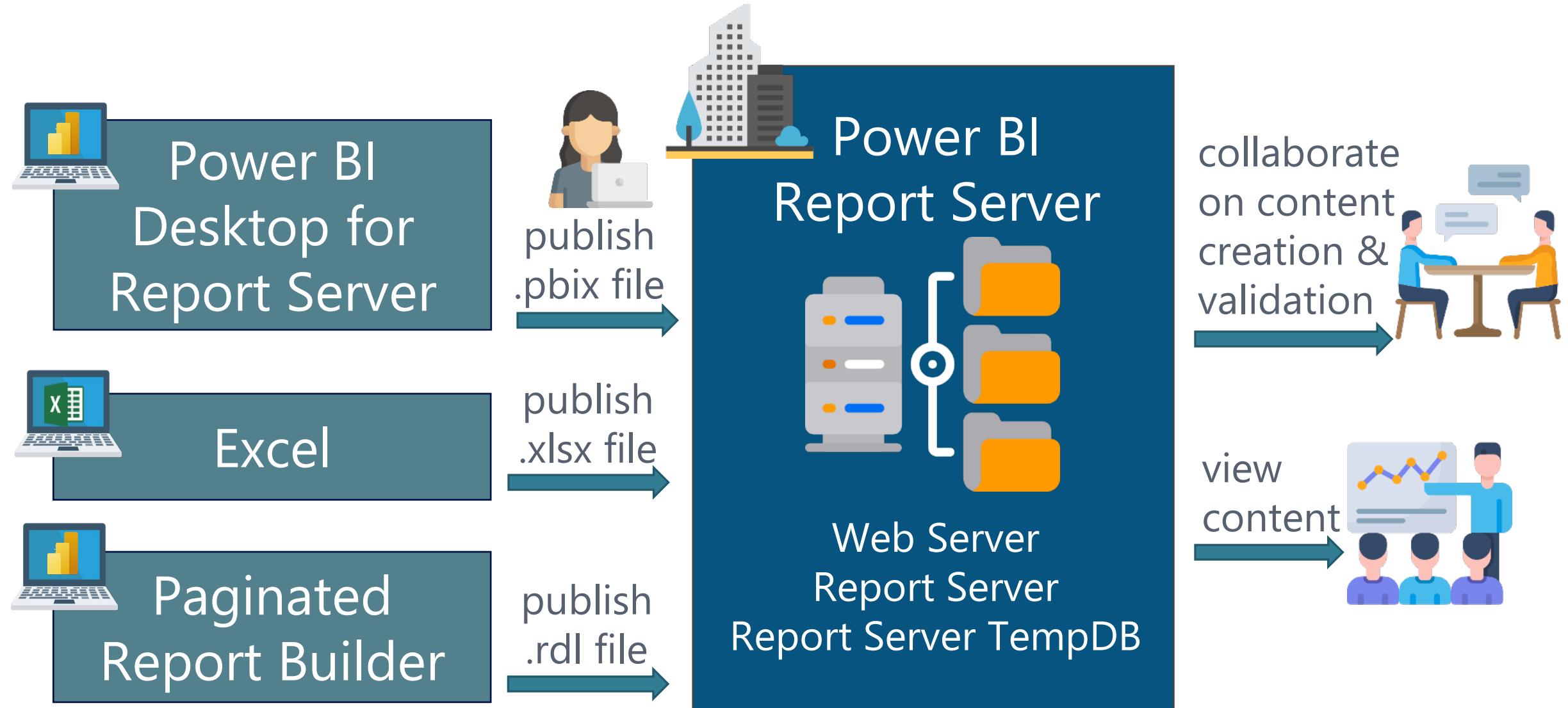
Power BI End-To-End: Top Features, Key Integration Points & Related Services

Last Updated: January 4, 2021





Power BI Report Server (PBIRS)





Top Reasons for Using PBIRS



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

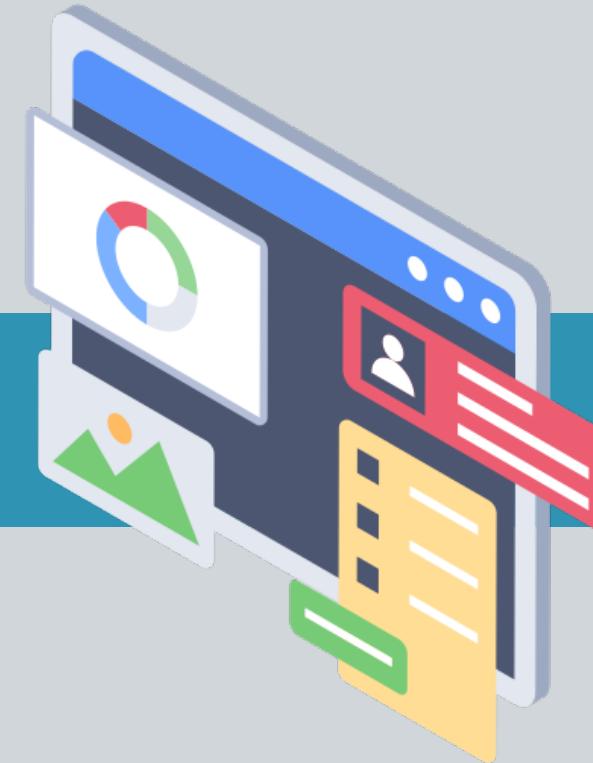


Existing significant
investment in
Reporting Services



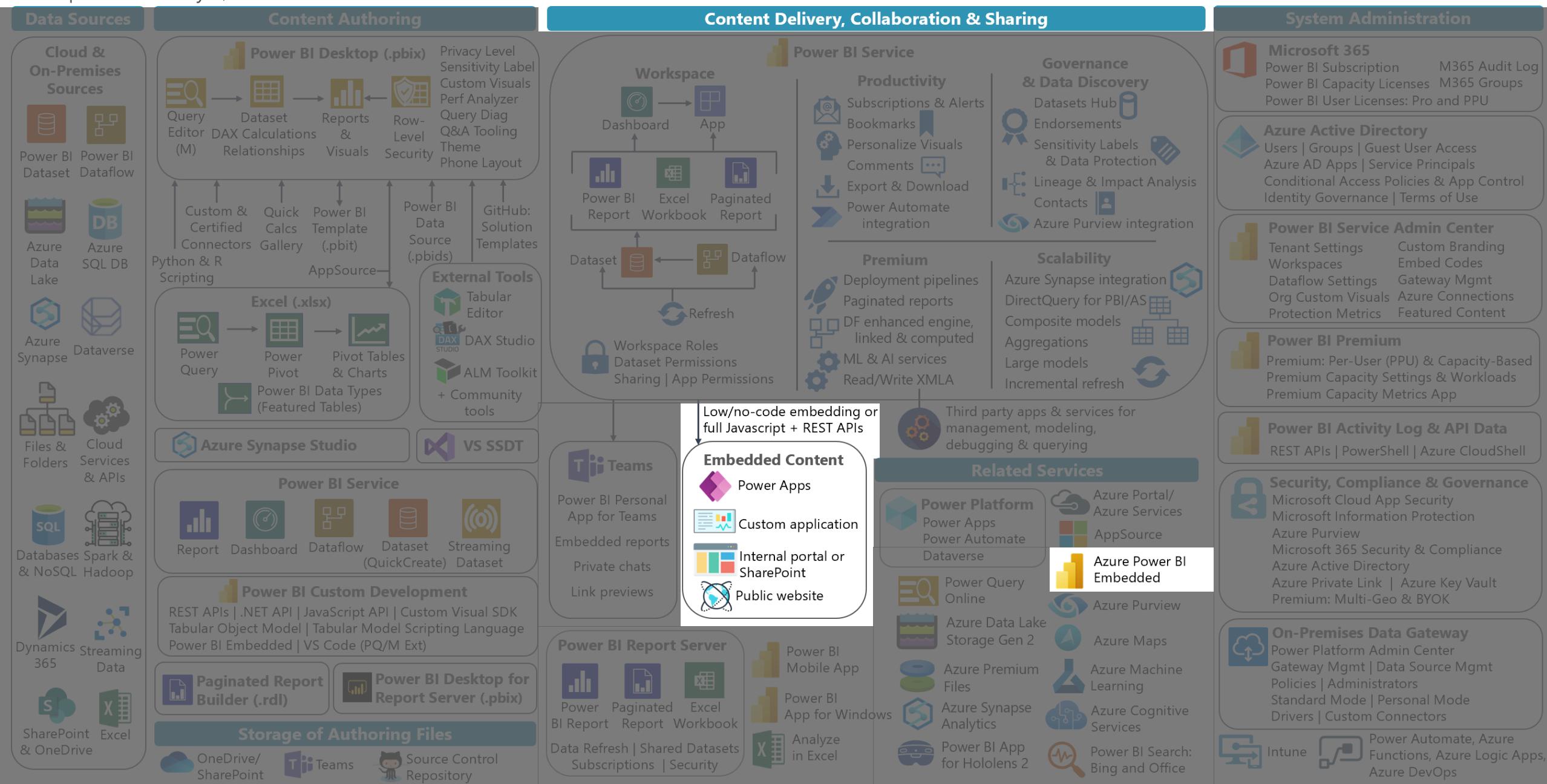
Desire a simple folder-
based reporting portal;
a slower release
cadence & a subset of
feature support is ok

Embedding Solutions

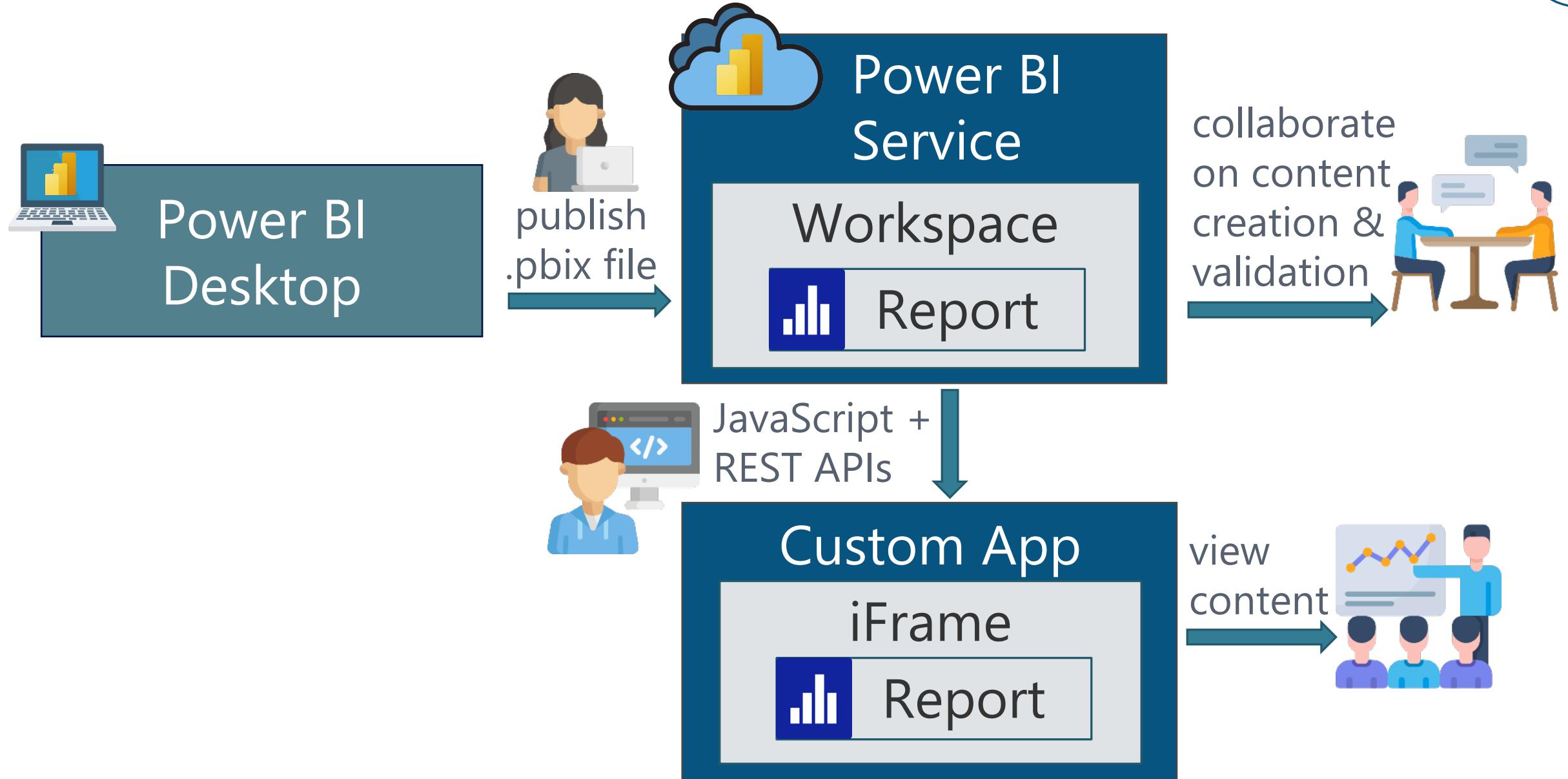


Power BI End-To-End: Top Features, Key Integration Points & Related Services

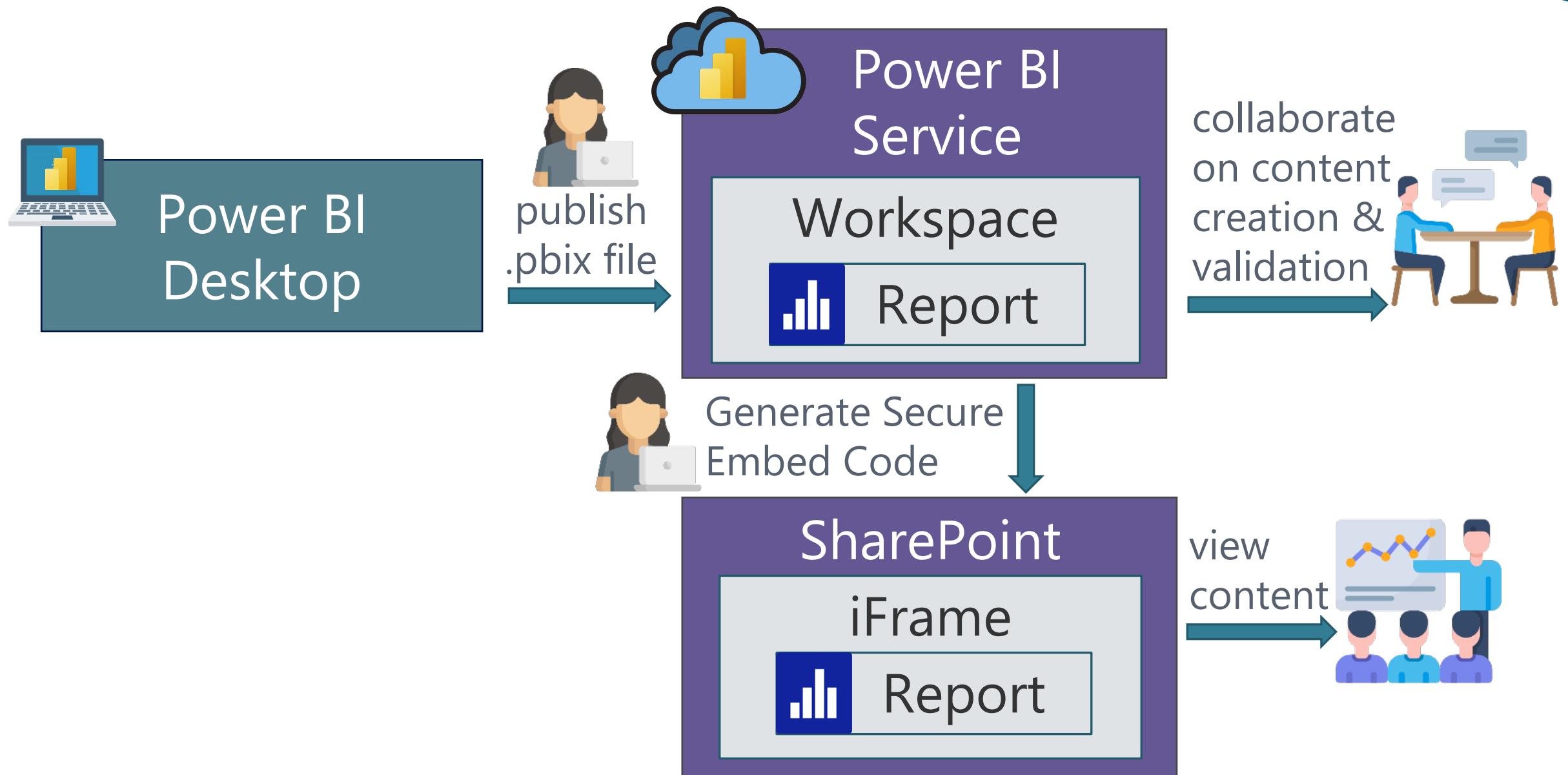
Last Updated: January 4, 2021



Embedding Content in a Custom App



No-Code Embedding





Options for Embedding Content

Internal Embedding

Embed for productivity
(no-code)



URL Embedding
for internal websites
and portals

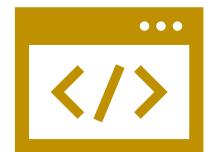


Embedding
in
Teams



Embedding
in
SharePoint

Embed for
your org
(user owns data)

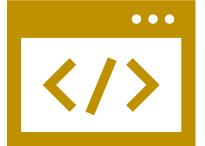


REST APIs:
Custom portals
and custom apps

External Embedding

Embed for
customers
(app owns data)

Public



REST APIs:
ISV apps and
services



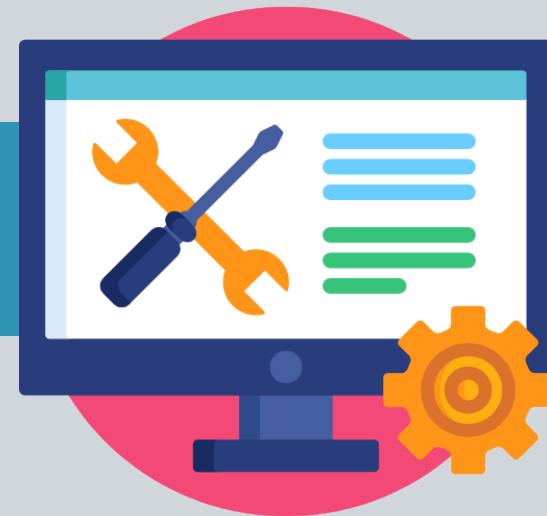
Publish to web:
public portals, open
data initiatives

Secured by organizational Azure AD

Secured by
application
authentication

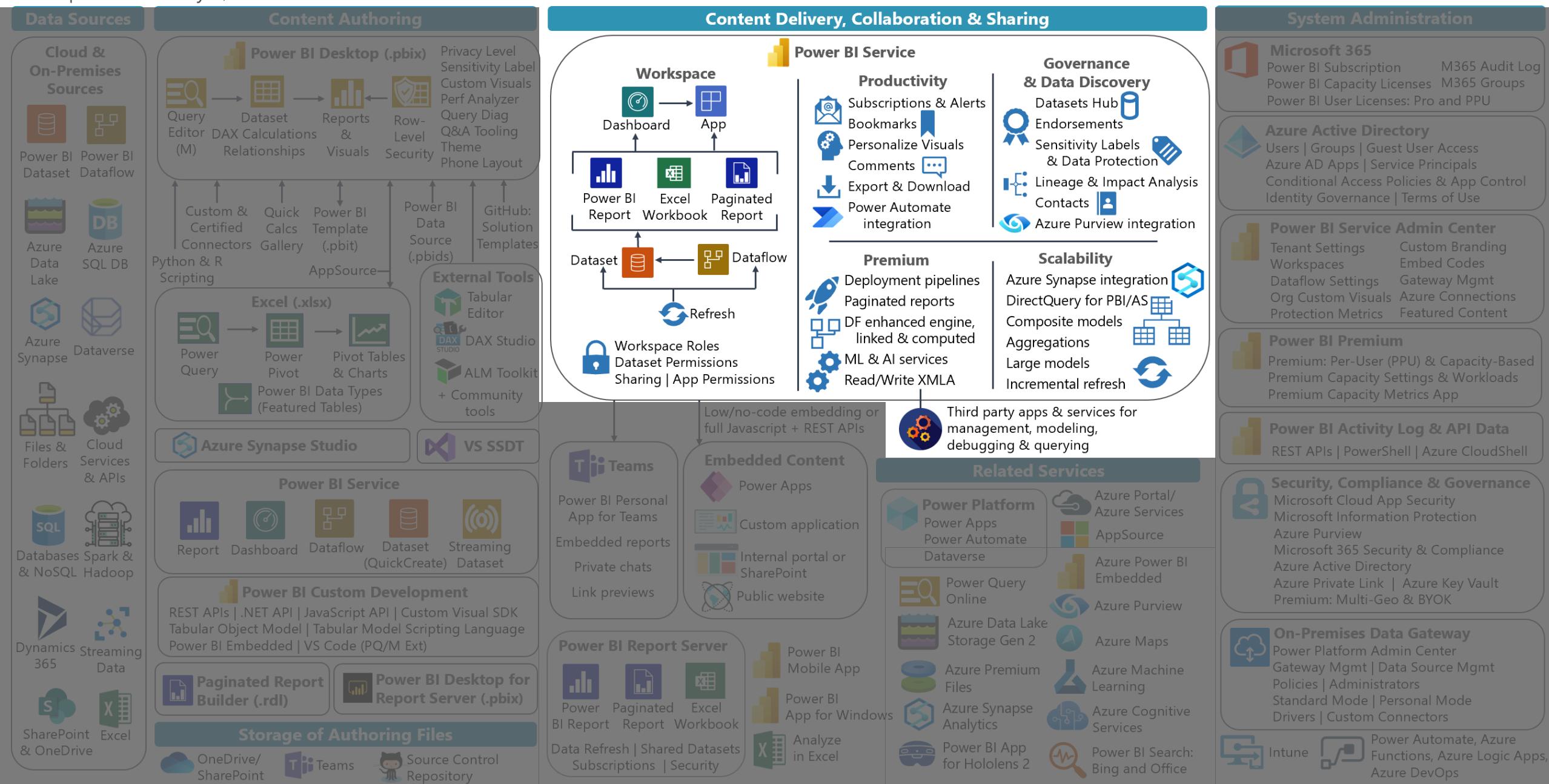
No user
authentication

Using Other Tools



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

Last Updated: January 4, 2021



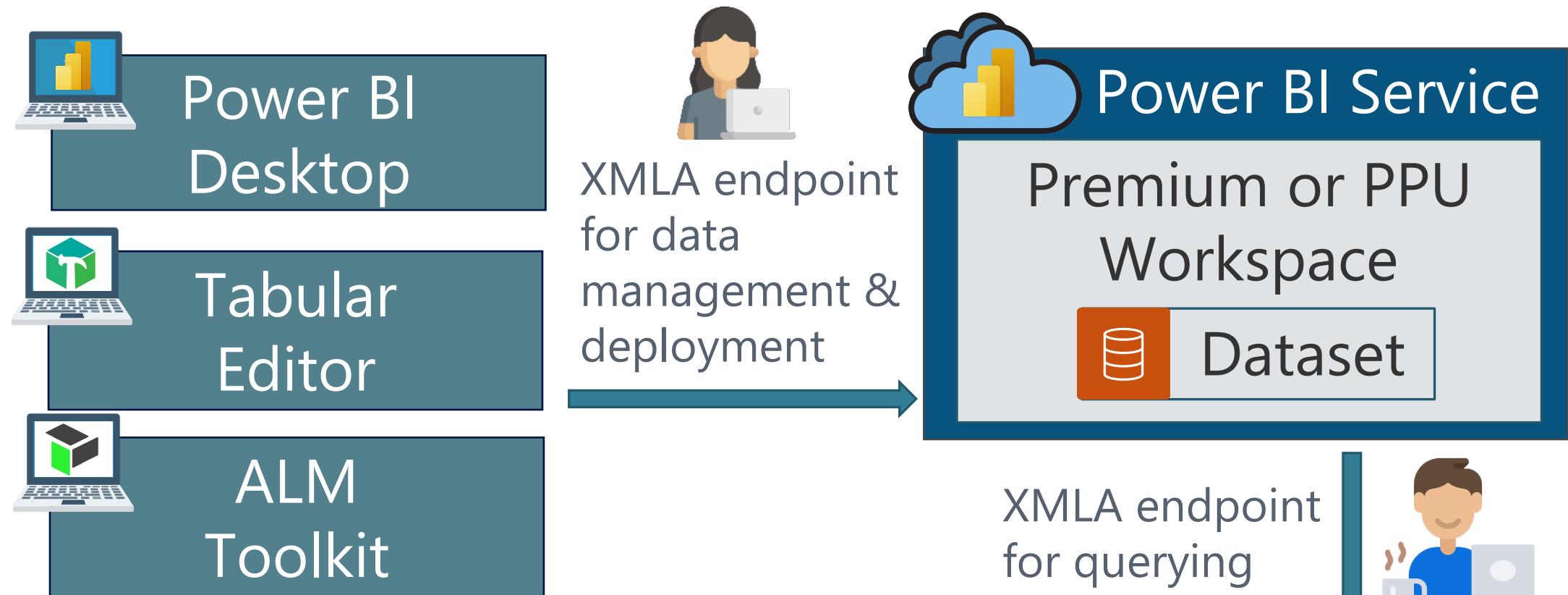


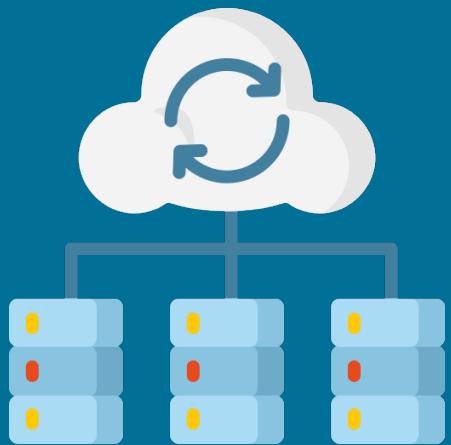
Using the XMLA Endpoint

XMLA = XML for Analysis

An industry standard protocol supported by BI vendors

Interacts with dataset via the Tabular Object Model (TOM)





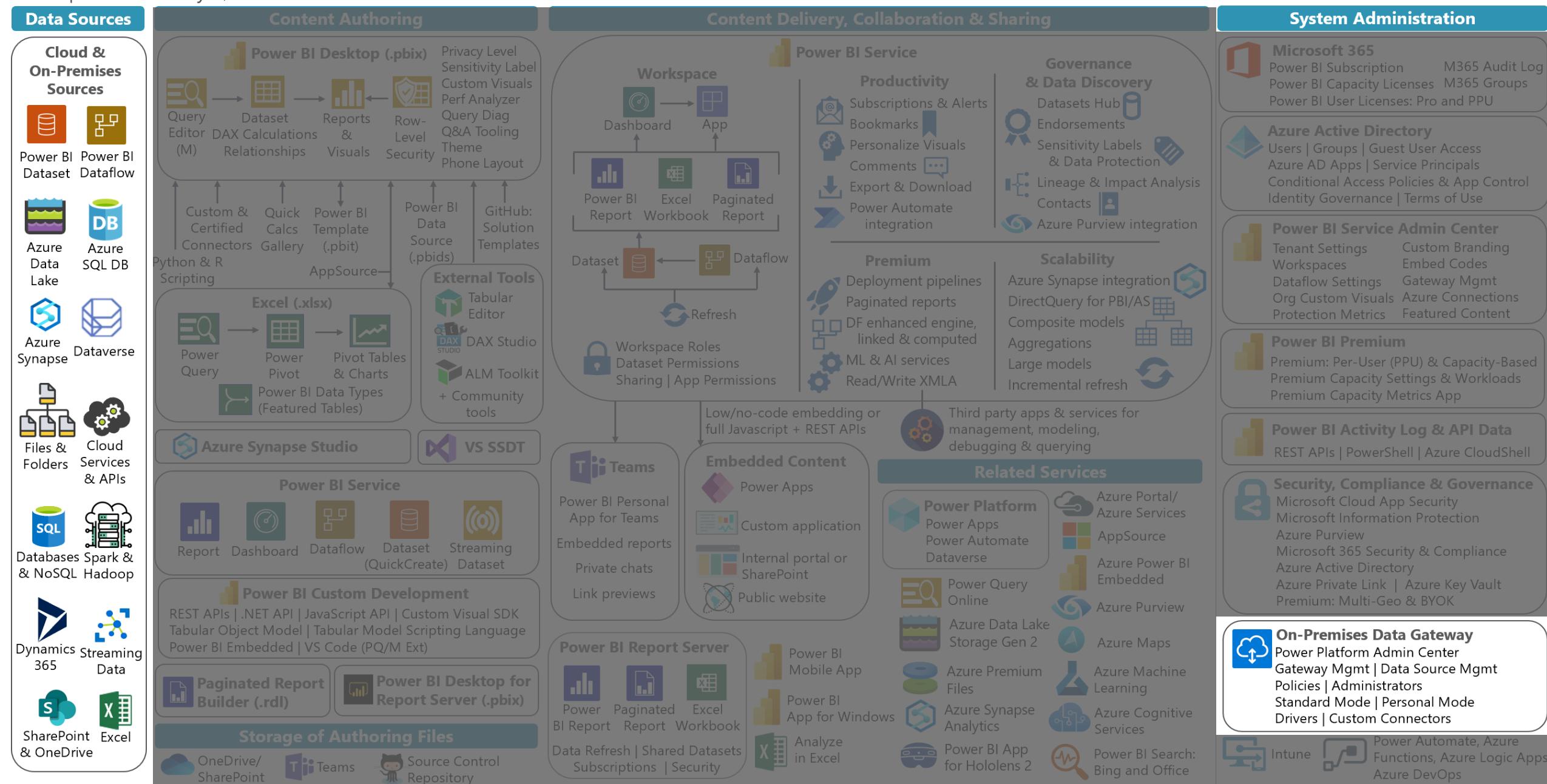
Other Key Components
in a Power BI Architecture

On-Premises Data Gateway



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

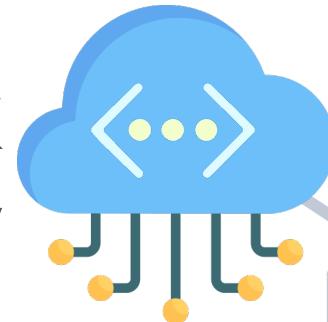
Last Updated: January 4, 2021



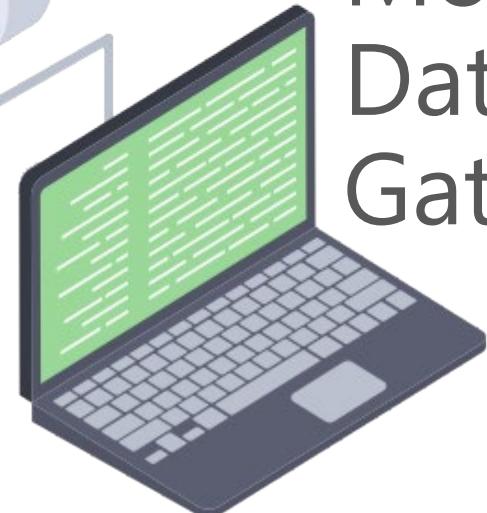
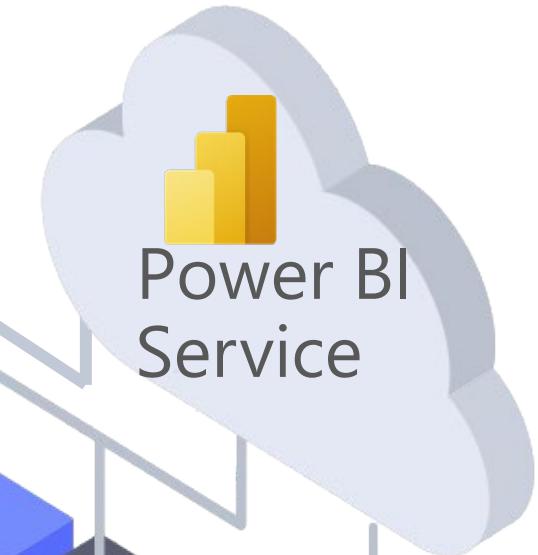


Three Types of Gateways

Virtual Network
Data Gateway



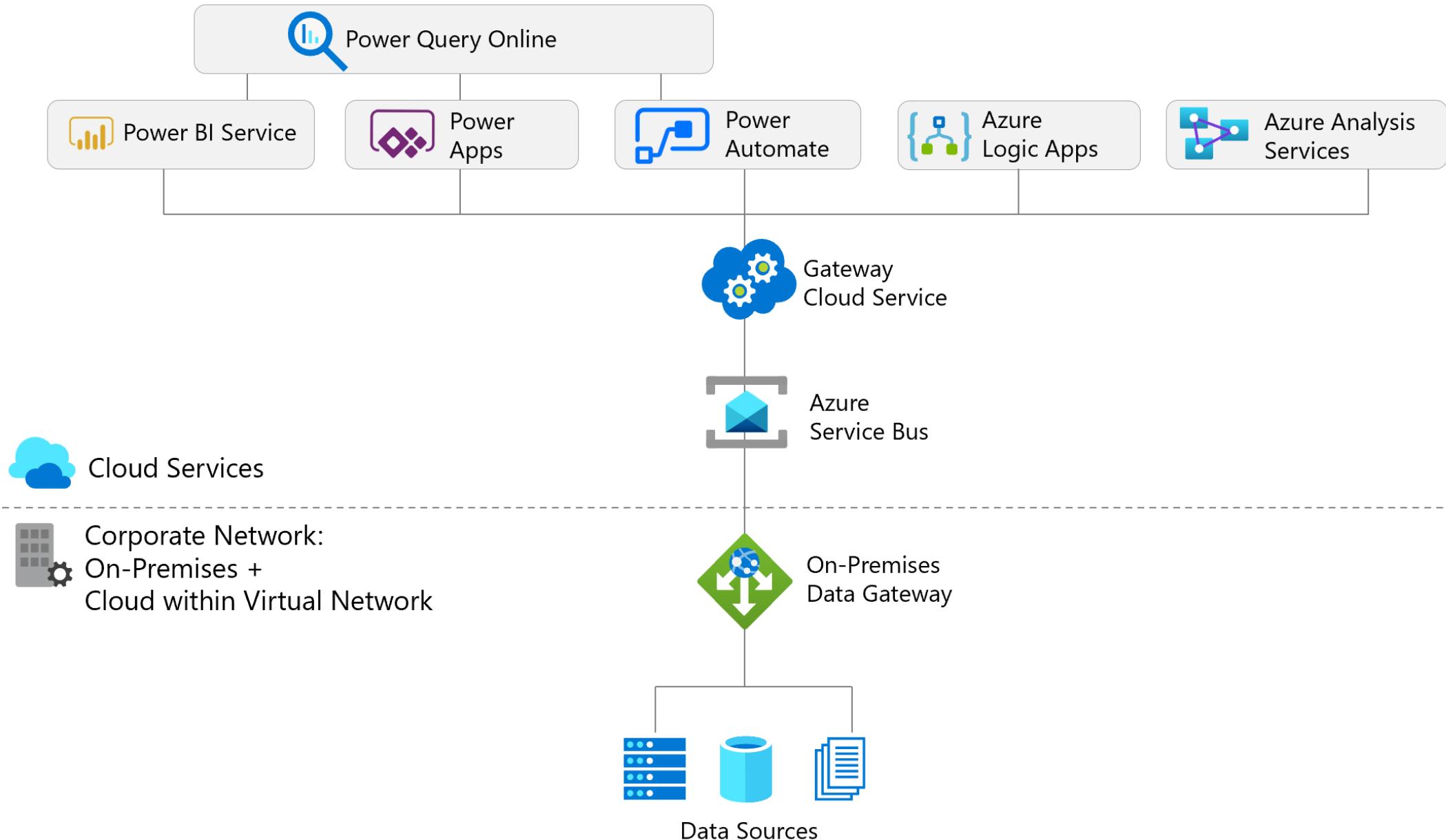
Standard Mode
Data Gateway Cluster



Personal
Mode
Data
Gateway



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

Data center within corporate network or on-premises

Refreshing dataflows

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

Using DirectQuery

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

Using Live Connection for Analysis Services

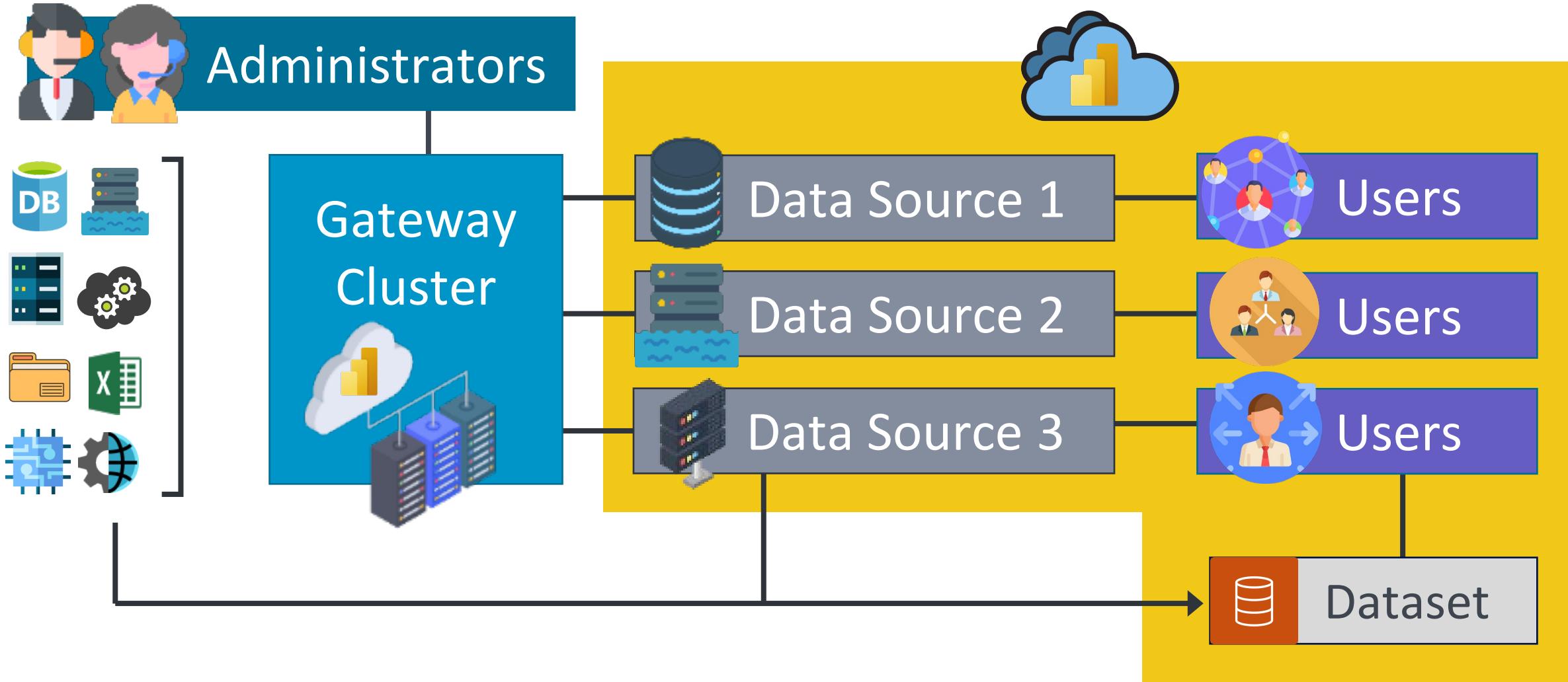
OR

Certain Functionality is Used:

Web.Page() function

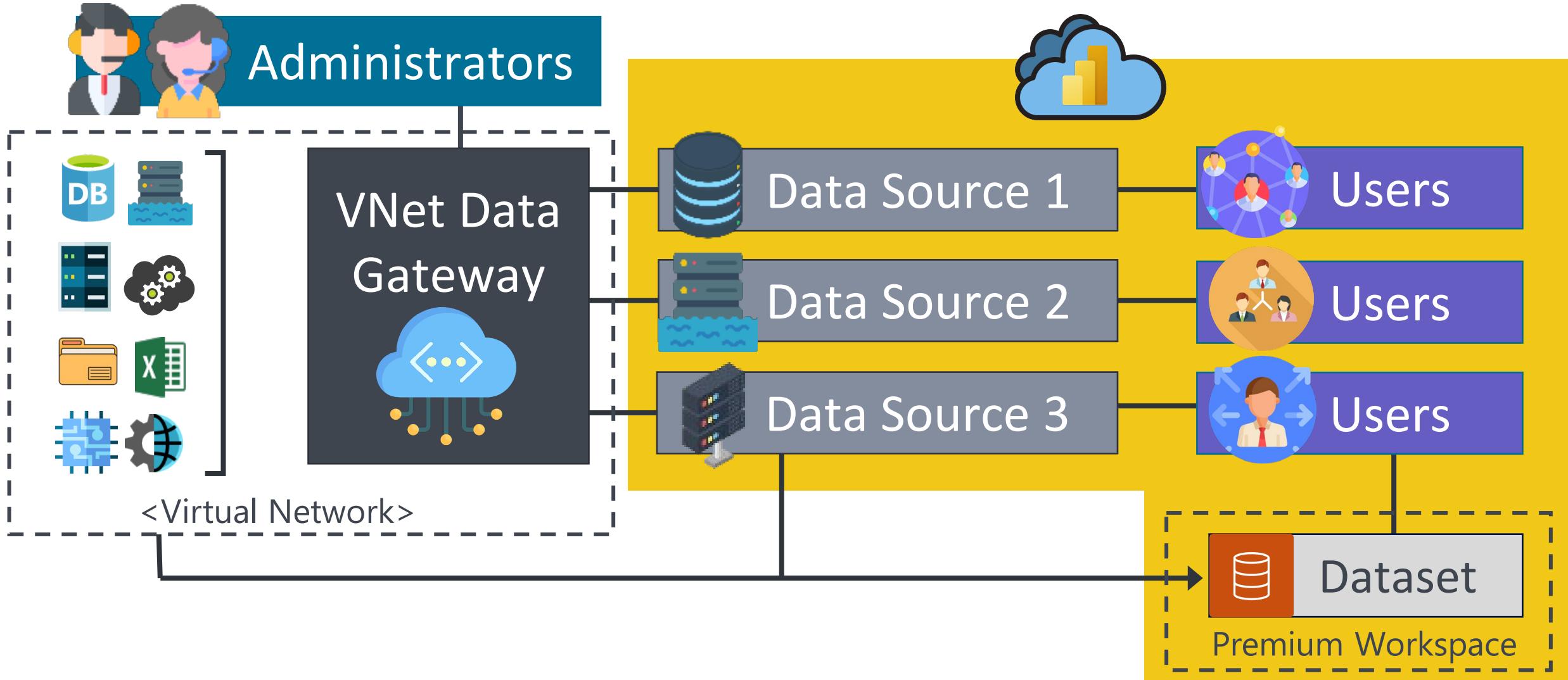
Single M query combines cloud & on-prem data

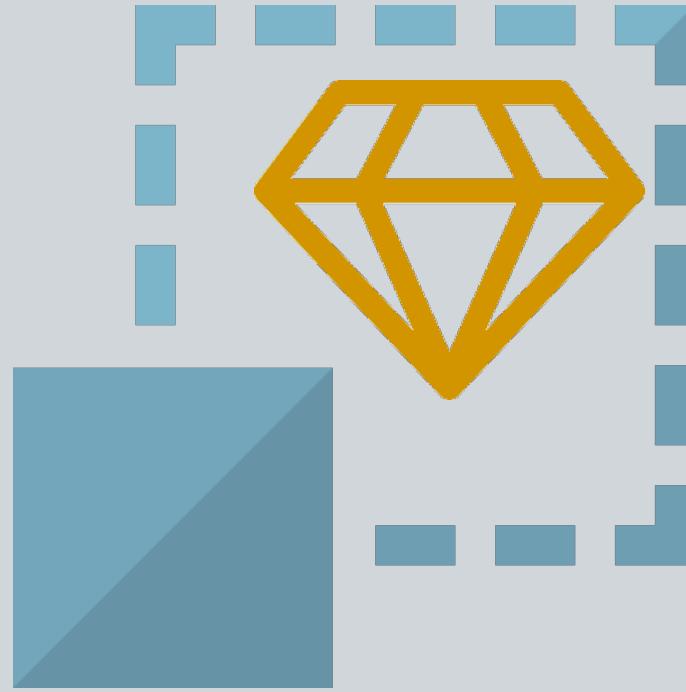
Standard Mode Data Gateway





Virtual Network Data Gateway

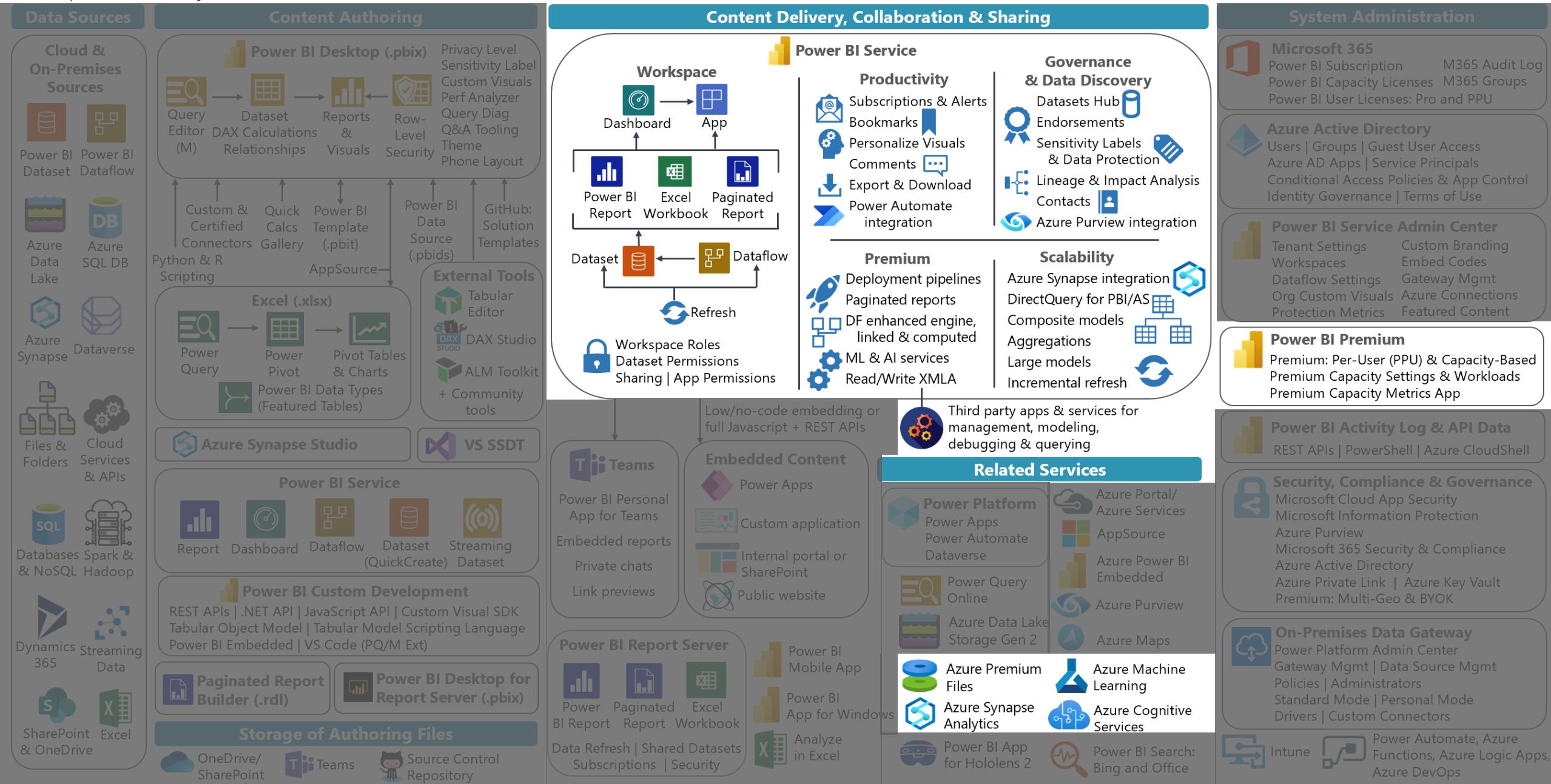




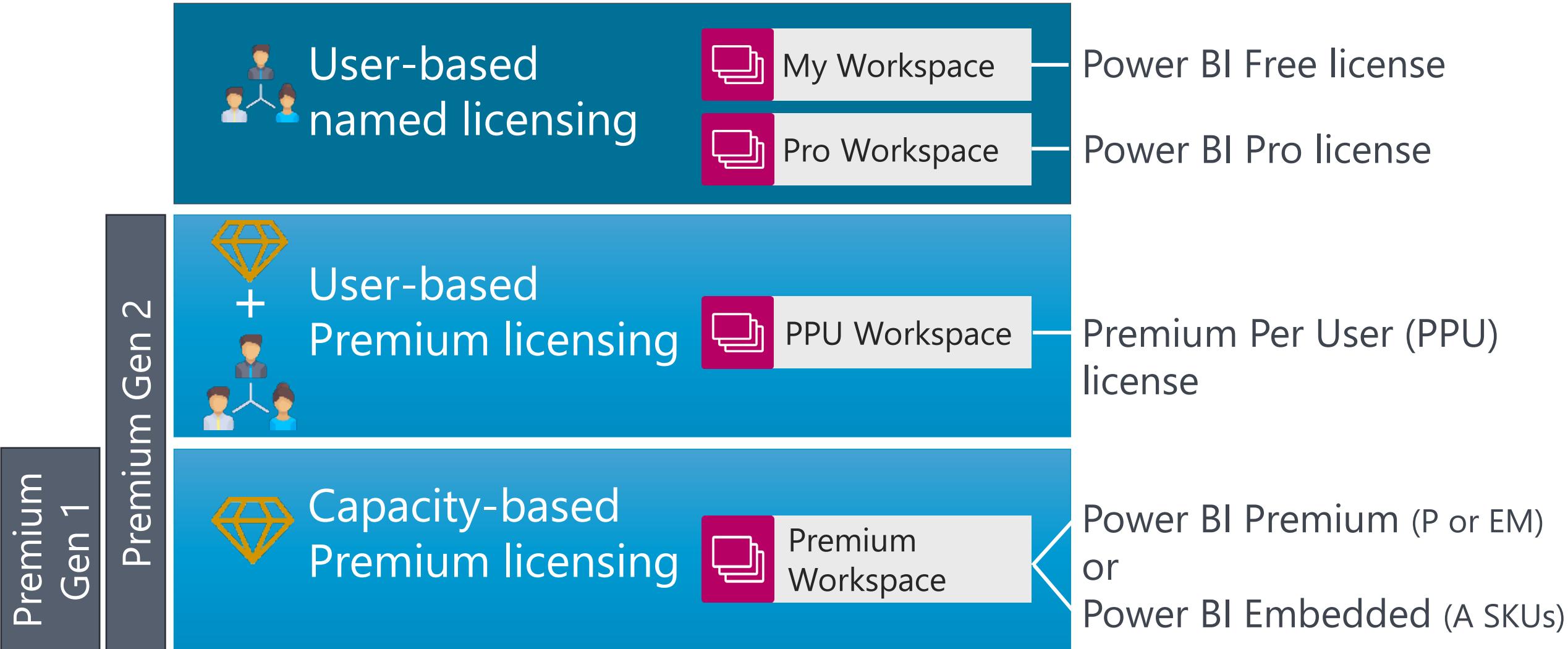
Power BI Premium & Premium Per User

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

Last Updated: January 4, 2021



4 Workspace Types are Based on Licensing





Who Can Access a Workspace?

Free User Pro User PPU User

Premium Gen 1	Premium Gen 2	User-based named licensing	My Workspace	X	X	X
		User-based Premium licensing	Pro Workspace		X	X
		Capacity-based Premium licensing	PPU Workspace			
			Premium Workspace	X	X	X



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

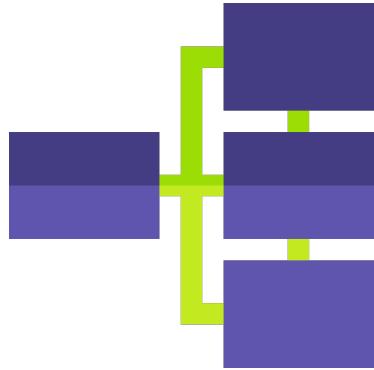
Not available with PPU



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

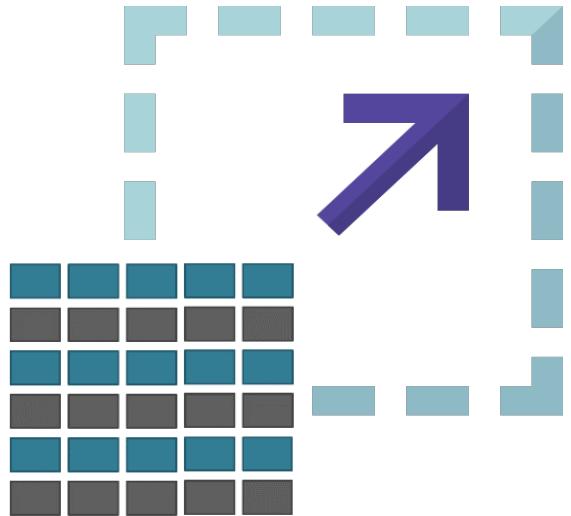


Top Reasons for Using Power BI Premium

Scalability

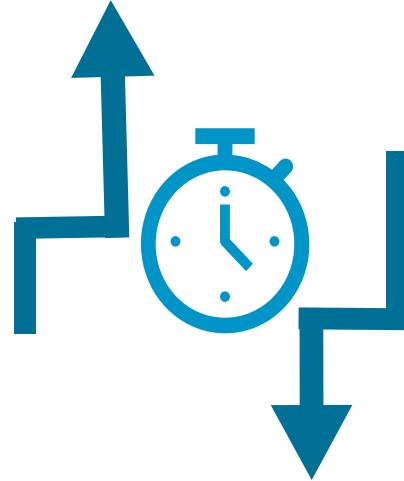


More frequent
data refreshes



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

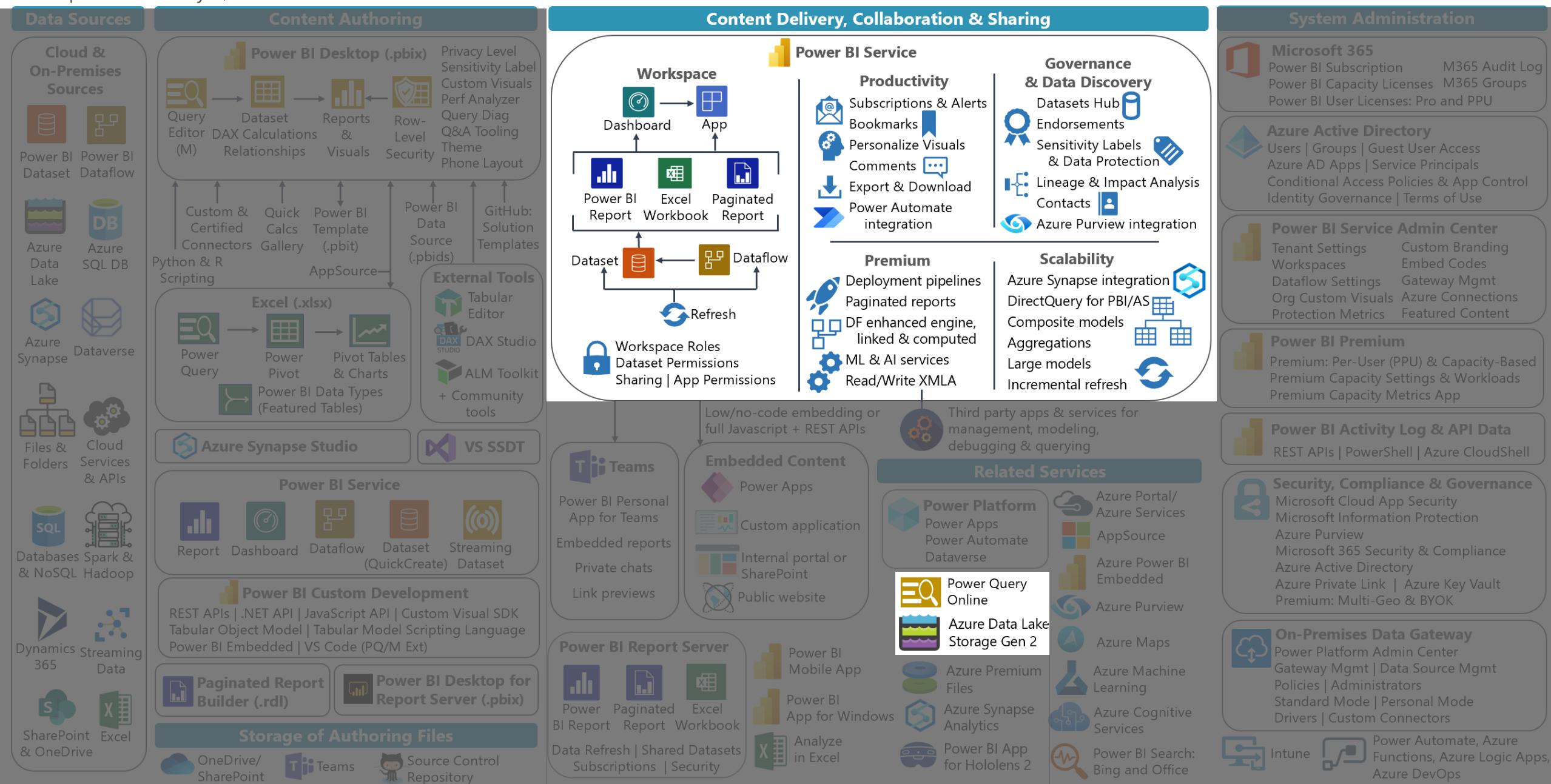
Not available with PPU



Power BI Dataflows

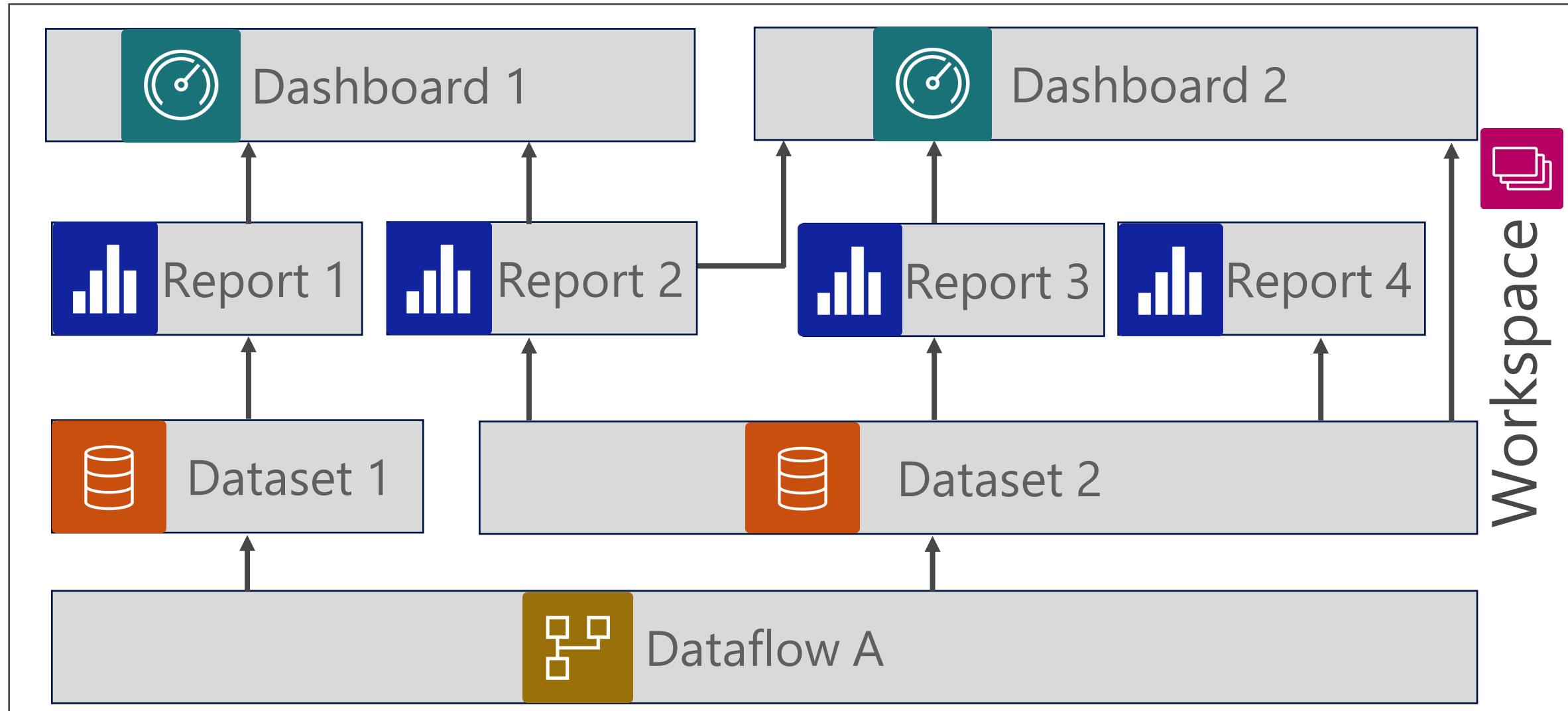
Power BI End-To-End: Top Features, Key Integration Points & Related Services

Last Updated: January 4, 2021



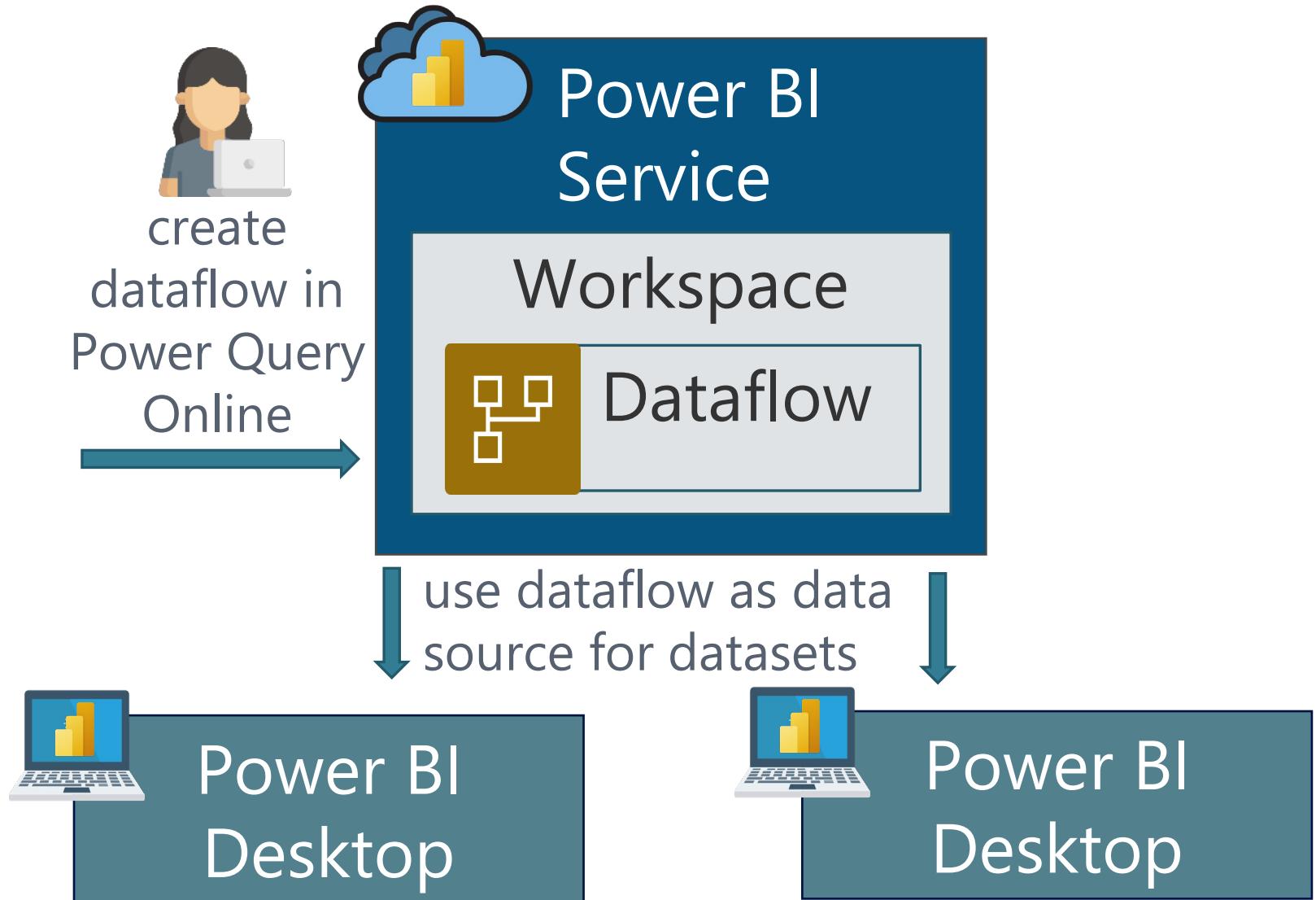


Dataflows in the Power BI Service





Dataflows

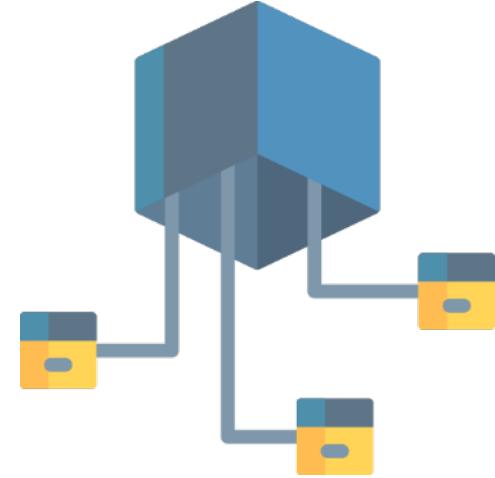




Top Reasons for Using Power BI Dataflows



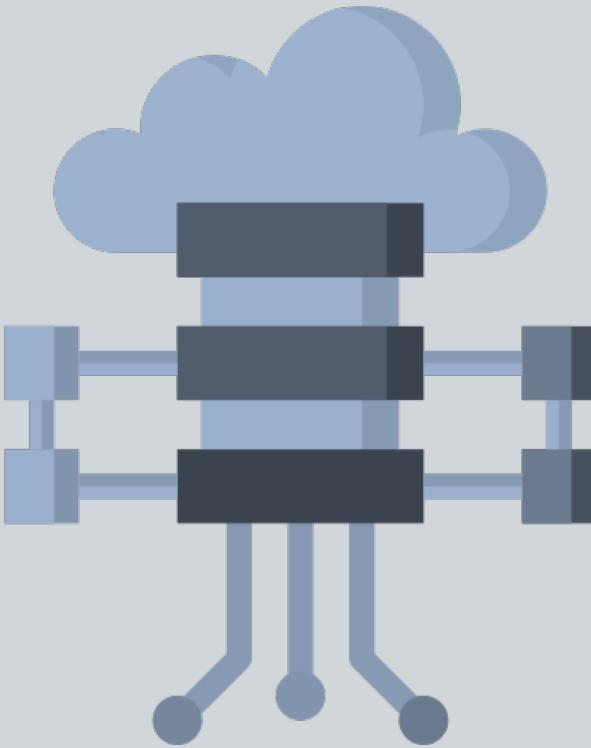
Reusable self-service data cleansing & preparation reduces repetitive work by data modelers



Standardized, consistent data consumed by many different datasets



Reduce load & queries sent to source systems



Other Components

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

Last Updated: January 4, 2021



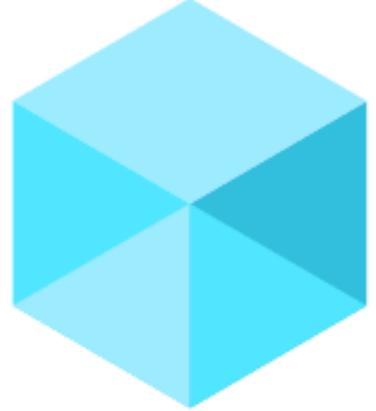


Integration with Microsoft 365

-  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

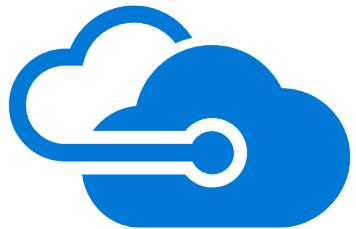
Common Data Service

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



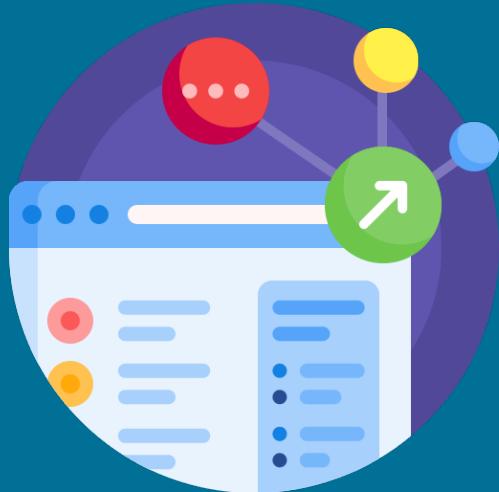
Microsoft Information Protection



Azure Key Vault



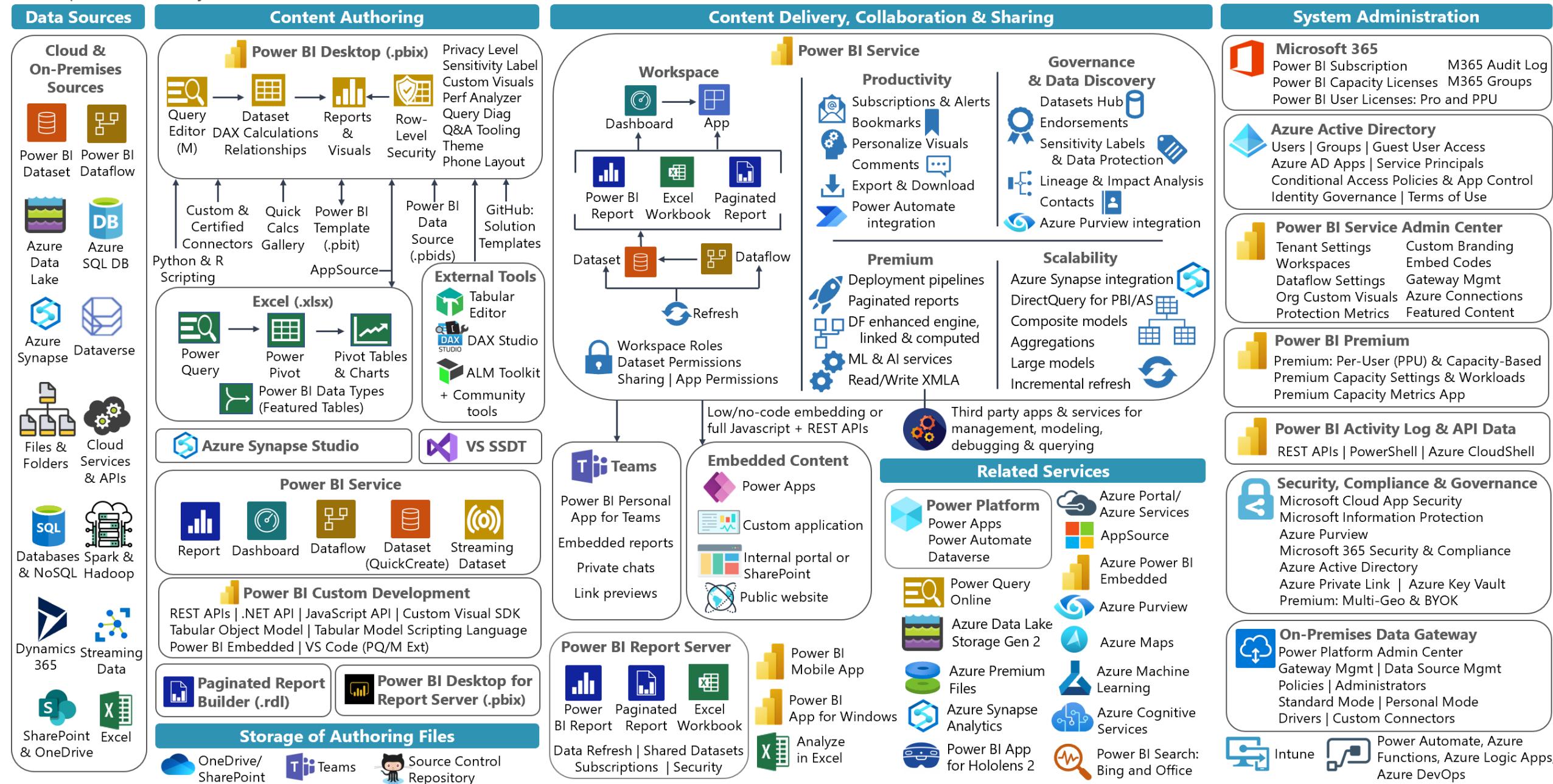
InTune (mobile app management)



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

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

Last Updated: January 4, 2021





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



YouTube:

YouTube.com/CoatesDataStrategies



Twitter:

[@SQLChick](https://twitter.com/@SQLChick) | [@CoatesDS](https://twitter.com/@CoatesDS)