Strategies for reporting in Finance and Operations: Should I build a data warehouse?

This document outlines two broad strategies for reporting that are available in Finance and Operations: system of intelligence and system of integration.
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Strategies for reporting in Finance and Operations: Should I build a data warehouse?

If you’re planning to implement Microsoft Dynamics 365 for Finance and Operations, Enterprise edition, or if you’re planning to adopt Finance and Operations for your business, you might be asking yourself these questions:

- How can we report from our enterprise resource planning (ERP) system?
- Should we use built-in capabilities or build a data warehouse?
- What does Finance and Operations provide?
- Can we use Microsoft Power BI or other business intelligence (BI) tools?

After all, you might be considering Finance and Operations because you require better visibility into your operations.

Ten years ago, the default approach was to build an enterprise data warehouse. Data warehouses are expensive to build and maintain, though the investments are less than they used to be. Although this approach is still valid, it’s no longer the default approach but just one of several options.

This document outlines two broad strategies that are available in Finance and Operations:

- **System of Intelligence** – Use and extend the ready-made capabilities of Finance and Operations.
- **System of integration** – Integrate with existing data warehouses and apps, or build a data warehouse.

Our goal in this document is to help you choose the appropriate strategy for your situation.

The document also briefly discusses key components and features for each strategy. We will focus on scenarios and prescribe options that fit those scenarios. Although the components and features might be useful in many scenarios, we recommend that you use them for prescribed scenarios wherever possible.

We will also offer roadmap guidance. Although this guidance isn’t binding, it will help you gain insights into Microsoft investments for the strategies.

The two strategies aren’t mutually exclusive. It’s very likely that you will use a combination of them. We recommend that you take advantage of as much ready-made content as you can, and we especially recommend that you use the ready-made capabilities as a starting point.

We will first discuss the two strategies.

### System of intelligence

You will hear the term *system of intelligence* in association with Finance and Operations. However, you might not know what the term means or how it differs from a *system of record* (SOR), which is the term that we have traditionally associated with ERP systems.

According to Wikipedia, an SOR is a data management term for an information storage system that is the authoritative data source for a given data element or piece of information. Typically, the information storage system is an ERP system that runs a database management system. For more information, see [https://en.wikipedia.org/wiki/System_of_record](https://en.wikipedia.org/wiki/System_of_record).
By contrast, a system of intelligence does much more. It provides business insights and lets user proactively take intelligent actions, all within the ERP experience. Here are some examples from Finance and Operations:

- **Analytical workspaces** – These workspaces help users navigate through interesting trends and patterns in data, so that they can quickly make decision about and take relevant action without leaving the report.
- **Intelligent business processes** – These processes offer suggestions and recommendations, based on a combination of business rules and artificial intelligence.
- **Modern financial reporting** – This new modern experience lets you create financial statements where you can slice and dice the ledger account balances on subledger data. You also have complete drill down across companies.
- **Rich and modern business documents** – Documents such as invoices and statements are an extension of your brand image. You can use configurable rules to print, email, and send rich documents that have multiple styles and branding.
- **Solution templates** – These templates enable mash-ups of external data from Internet of Things (IoT) devices and social media to provide a holistic picture of the ecosystem.

As you will see later in this document, Finance and Operations is a system of intelligence for your business operations. It offers embedded analytics and intelligence. Users of Finance and Operations get lots of value by using the built-in capabilities.

### System of integration

The ERP system might be an important source of data in your organization. However, your data might currently (and for the foreseeable future) be spread across disparate systems. In these cases, you can integrate the systems by using established service integration principles. You might be using service integration strategies such as Open Data Protocol (OData), SOAP, or an enterprise data integration suite.

Perhaps you have a corporate data warehouse that you previously implemented, and your users insist that they should be able to continue to use dashboards and reports that have been built over the years.

We will refer to an ecosystem of this type as a system of integration. Finance and Operations supports a system of integration that has the following capabilities:

- **Read/write by using OData Version 4 (V4)** – Over 1,700 entities in Finance and Operations are securely exposed via the OData V4 endpoint for interactive read/write operations that involve small batches. (As of platform update 7, the OData interface limits the number of records that are extracted at a time to 10,000 rows.) Although OData V4 endpoints can be used for reporting that uses Power BI and other tools, for large-volume reporting, we recommend that you use BYOD. You can access the OData V4 endpoint at the following URL: https://<your Finance and Operations base URL>/Data.

- **Integration service framework** – The integration service framework lets you build custom RESTful services by using pre-existing (or new) business logic that is written in X++ in Finance and Operations. JavaScript Object Notation (JSON) is an efficient protocol for exchanging data between interactive applications. Although you use the same endpoint that you do for OData V4 to access entities, you can invoke business events and actions in addition to accessing data.
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- **Data Import/Export Framework (DIXF)** – DIXF enables large batch import and export operations that can be carried out on a scheduled basis. Pre-built import/export templates enable both one-time migration efforts and bulk data transfer for specific scenarios. You can use DIXF functionality via the Data management workspace or programmatically by using RESTful application programming interfaces (APIs). DIXF supports many export destinations, such as text files, comma-separated values (CSV) files, and Microsoft Excel files. It also lets you troubleshoot and resolve typical issues that are associated with data import and export operations.

- **Bring your own data store (BYOD)** – BYOD is designed to support integration with data warehouses. Finance and Operations entities can be incrementally exported to your own data warehouse or a staging database as frequently scheduled batch transfers. BYOD is built by using DIXF and uses the same robust functionality. Integration via SOAP/XML services and the document services that are offered in Microsoft Dynamics AX 2012 are supported, but have been deprecated in favor of the more efficient interfaces that are described here.

## System of intelligence vs. system of integration

We’ve discussed the different strategies, namely;

- **System of Intelligence** – Provides reporting and insights embedded within the application.
- **System of integration** – Integrates insights from several systems.

Which option should you use? Should you use ready-made capabilities that are provided in Finance and Operations (that is, the system of intelligence approach), or should you build a system of integration?
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The following table summarizes the main differences between the two strategies.

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We will now briefly explore the main differences and major architecture components.

**Reporting tools and options in a system of intelligence**

The following illustration summarizes the reporting tools and options that are available in Finance and Operations.

Embedded chart controls are used to build embedded experiences that require visualizations on pages and in workspaces. Although we will continue to support the developer-focused chart controls that are currently available, you can pin Power BI tiles to complement this functionality. Eventually, we will introduce functionality that lets you pin Power BI visuals deeply on client pages.

Finance and Operations takes advantage of Microsoft SQL Server Reporting Services (SSRS) for document-style reports such as invoices and purchase orders. SSRS is an engine that is designed for pixel-perfect formatted reports that often require printing. Although SSRS reports that are migrated from Microsoft Dynamics AX 2012 R3 will continue to work in Finance and Operations, our investments in the SSRS integration are focused on document
generation and printing scenarios. For all non-document reports or reports that don’t have to be printed, we want to embrace Power BI.

Often, you might hear the term **self-service reports** or **dashboards** used in reference to Power BI. In the future, we will use the term **data exploration**. A subtle shift in paradigms lies behind this change of terminology. Self-service reports were reports that the users created for themselves (or a power user created a report and shared it with other people, who continued to adjust it to meet their requirements). Often, users must change the shape of a chart, add a new column, change the grouping, or just create a new view of data. We can think of the result as a report. However, as a user, you’re just trying to understand the data, exploring it, pivoting it around columns, changing the shape of charts. Technologies of the past didn’t let you interactively explore large volumes of data. Therefore, users had to resort to creating “reports,” or many views of the same data.

Thanks to in-memory database technologies in Entity store and Microsoft SQL Server, a report in Power BI is a just the starting point for interactive data exploration. Charts in a Power BI report invite users to click them, visuals change shape interactively, and data can easily be filtered. Users can easily adjust existing reports and create their own views of the data. The reports can be shared, and teams can collaborate over data. We refer to this style of information access as data exploration.

Financial reporting is an option for viewing, interacting with, and modifying financial statements. Users can apply reporting hierarchies, and can drill down to transaction-level detail across all companies for analysis and audit. Future releases will offer a modern financial reporting experience that is built by using Power BI experiences.

Electronic reporting (ER) is a specialist tool that is designed to export data for regulatory requirements.
Analytical workspaces

Finance and Operations provides lots of value in ready-made analytical workspaces. Analytical workspaces are workspaces that include the new Analytics tab. An example of an analytical workspace is the Manage customer credit and collections workspace that is shown in the following illustration.

This ready-made workspace is designed to reduce the collections cycle and improve the cash flow. By using the interactive visuals and contextual action items, a credit or a collections manager can review, follow up, and take proactive action.

Ready-made, Power BI–based reports in analytical workspaces are designed to work with Finance and Operations data. Think of analytical workspaces as “next-generation reports”: they are interactive and rich, and provide both summary and detailed data.

Analytical workspaces involve embedded Power BI technology. Although they use a Power BI canvas for reporting, the experience is deeply integrated into Finance and Operations. When you select a specific company or a context variable in the workspace, the report reacts and filters data. Reports also let you drill back into lists and transaction pages in Finance and Operations to take action. In this case the context is preserved, so that only the data that is related to the visualization is shown on the pages.

A single analytical workspace provides many views of the data, so that you can take a wholistic view. Microsoft will continue to invest in more analytical workspaces. In fact, we are re-imagining many reports from Microsoft Dynamics AX 2012 as embedded Power BI reports that are built into analytical workspaces.

As a customer, partner, or independent software vendor (ISV) developer, you can extend ready-made analytical workspaces or build new workspaces that include embedded Power BI reports. For resources and guidelines, see the Next steps: Resources for a deeper consideration section at the end of this document.
Entity store: The built-in operational data store

Entity store is an operational data store that is included with Finance and Operations. Entity store is dedicated to reporting and analytics workloads. It contains a set of star schemas that are useful for operational reporting scenarios.

The Entity store schema has been simplified to enable easy and performant reporting that uses Power BI. Entity store organizes a selected set of entities into a star schema. (For example, transactional entities that are known as fact tables are stored together with master and reference entities that are known as dimensions.) We refer to these star schemas as aggregate measurements. Both aggregate and detailed reports can be generated by using data that is stored in Entity store.

Entity store uses the in-memory, clustered columnstore index (CCI) functionality that is built into SQL Server to optimize reporting and queries. CCI technology enables interactive reporting experiences that use both detailed and summary data, but doesn’t affect the transactional workload of Finance and Operations.

The Entity store feature was introduced in platform update 1 (May 2016). In each monthly release since then, we have enabled additional capabilities. Currently, you can schedule updates of Entity store. However, unattended, near-real-time synchronization between the Finance and Operations database and Entity store is planned for a future release.

Operational reporting via Entity store

Entity store is designed for operational reporting that uses Power BI. Rebuilt integration with both embedded Power BI (that is, analytical workspaces) and the PowerBI.com service lets you use Power BI tools to create operational reports that use data in Entity store.

Entity store has been designed for integration with Power BI DirectQuery mode. In DirectQuery mode, Power BI reports can be run directly on Entity store. The Power BI service doesn’t have to be used to cache data. This functionality is especially useful in operational reporting scenarios where reports must reflect data in near-real time.

By using the Power BI Desktop tool, power users can create compelling, high-volume, near-real-time analytical reports that use Entity store. The reports that are created can be deployed to the PowerBI.com service and shared with other people. When DirectQuery technology is together with Entity store, the data can be hosted in a Finance and Operations environment at all times. Your data never leaves Finance and Operations.

Reports that are created by using Entity store can be distributed between environments by using Microsoft Dynamics Lifecycle Services (LCS), which is the same service that is used to migrate artifacts between environments. LCS lets you migrate reports between, for example, test and production environments, but also helps guarantee that the reports always point to the corresponding Entity store.

After the reports are published to PowerBI.com, your users can use collaborative features in the Power BI service. For an example, they can create rich dashboards that include tiles that are drawn from across the application. For ease of access, tiles and reports that have already been published to PowerBI.com services can be pinned to workspaces.
Incorporating reports in analytical workspaces and operational reports

Reports that power users create by using Entity store can easily be incorporated into analytical workspaces, so that they are tightly integrated into the ERP experience. This operation requires a developer.

What is the difference between analytical workspaces and reports that are published to PowerBI.com?

- **Analytical workspaces offer contextual analytics.** Reports in an analytical workspace react to the context of the Finance and Operations client. For an example, if a workspace has filters that are related to expense items in a cost center, reports in the analytical workspace react to the filter. If a user who has access to multiple legal entities in Finance and Operations changes the legal entity that is in focus, analytical workspaces automatically change the context company.

- **Analytical workspaces let you drill back to Finance and Operations to take action.** Although reports on PowerBI.com can contain links that navigate the user to a Finance and Operations page or workspace, you can also build rich drill-back actions by using analytical workspaces. By using the extensibility framework that is provided in Finance and Operations, developers can add deep drill-back actions in a report. For example, when a user clicks a slice of a chart, you can drill back to a details page that contains the exact record. Alternatively, you can react to a user click by creating an order or a work item.

- **Analytical workspaces take advantage of embedded Power BI licenses.** Your users don’t have to have a Power BI account to access analytical workspaces. Embedded Power BI licenses are included in your Finance and Operations subscription.

As you saw earlier, reports that are created by using Entity store can be incorporated into Finance and Operations as operational reports that enable deeper integration with ERP functionality.

Extending Entity store

By default, Entity store includes a set of ready-made star schemas that focus on major subject areas. Ready-made star schemas are referred to as aggregate measurements in developer documentation. The word *aggregate* reflects the star schema’s ability to aggregate data on the fly. Aggregate measurements do contain detailed data, and they are aggregated on the fly using in-memory BI technologies built into SQL Server.

Ready-made star schemas react to your system configuration. For an example, when you configure your chart of accounts to use financial dimensions, the same financial dimensions are reflected in Entity store for reporting.

As a developer, you can extend entities and aggregate measurements by using Microsoft Visual Studio tools. Extensions and customizations that are applied to entities in your system can be applied to aggregate measurements for reporting. You can also create new aggregate measurements for additional subject areas.

If you’re a customer that is upgrading from AX 2012, you might have used default cubes or created your own cubes by extending them. You might have also created new cubes by using perspective definitions, which are the

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1. Clustered ColumnStore Index (CCI) technology enables in-memory aggregation of large amounts of data. This eliminates the need to pre-aggregate data and store them as a separate set of tables.
underlying metadata concept for cubes. The good news is that your perspective definitions will be migrated to aggregate measurements as part of the code upgrade process.

Modern financial reporting

Financial reporting will become a new, modern, and powerful experience for navigating financial data. Users will start from familiar statements that span companies and financial dimensions, but can then expand their view to analyze trends and abnormalities. Financial users will be able to analyze data using extended attributes such as Customer, Customer group, Vendor, or Project. Visualizations of the data can be created by using embedded Power BI functionality, and users can then drill down to originating documents and lines of data.

The new modern financial reporting experience will be showcased in the next major product update of Finance and Operations. We will continue to address end-to-end scenarios in future releases until a complete financial reporting solution is available to replace the financial reporting solution that is currently available.

Blurring the boundary between financial and non-financial data by using Entity store

Financial reports can contain much more than just financial data. Your financial reports can be enhanced so that they include customer, vendor, employee, or project details. For example, you can create a report that shows the cost of hiring employees or the cost of customer acquisition in a specific category.

You can define the chart of accounts by using attributes that you select from hundreds of ERP data entities, such as Customer, Vendor, Employee. This functionality is referred to as financial dimensions. You can report not only on your financial data but also on extended data in each ERP data entity. For example, by associating payables with the Vendor data entity, you can explore payables by vendor group or vendor rating. Alternatively, by associating payroll with the Employee data entity, you can seamlessly analyze payroll expenses by experience and skills. This functionality is already available in Finance and Operations under the configuration options for financial accounting.

By combining the financial reporting engine with Entity store, the near-real-time operational data store that is used by Finance and Operations, we have enabled almost limitless possibilities for reporting on both ledger data and extended entities.

Customer-facing documents

Invoices, purchase orders, and customer statements are a few examples of documents that must be printed and sent to your customers either as PDFs that are attached to email or in printed form. Customer-facing documents give you an opportunity to showcase your corporate image and branding, and to communicate with your customers through personalized messages.
To produce documents, Finance and Operations takes advantage of the enterprise-grade features that are offered by SSRS. We have also made investments in SSRS in Finance and Operations, to provide modern document designs, integrated developer tools, and administration capabilities.

As a developer, you can generate documents programmatically and include business logic in them. Advanced ERP concepts such as rich types, language support, business logic, and integrated security are applied to document reports. You don’t have to reconstruct these concepts in SSRS. Although documents can be viewed interactively, you can also use the high-performance scheduling and routing capabilities of the Finance and Operations batch framework to orchestrate document production.

The Document Routing Agent is an on-premises gateway that is installed as a network service in your edge deployment. The Document Routing Agent enables documents that are generated overnight (for example, after day-end business processes are completed) to be printed to physical printers. In this way, the documents are ready to be mailed or handed out the next morning.

Following are two examples of customer-facing documents that are included in the system. Customers can download additional designs that are distributed by Microsoft and partners using LCS.

By using the document branding and configuration functionality that is included in Finance and Operations, power users can change document designs without requiring the help of a developer. You can incorporate colors, styles, custom messages, and brand images into document designs. You can also define business rules that enable designs to be selected at runtime. For example, you can send different document formats, depending on the number days
that an invoice is outstanding or the customer’s location of the customer. If you have customers that are based overseas, you can send documents that are printed in their native language. You can even print in right-to-left languages such as Hebrew and Arabic. This functionality is known collectively as print management.

BYOD

So far, we have discussed how to use the built-in Entity store. For operational reporting scenarios, you should take advantage of Entity store and analytical workspaces. However, you might encounter scenarios where you must build your own data mart or a reporting database. We refer to this scenario as bring your own data store (BYOD).

You might require BYOD for the following scenarios:

- **You want to integrate data from Finance and Operations into an existing data warehouse.** You might have a data warehouse that is already used. Although you take advantage of Entity store for operational reporting, you might want to use reports from the data warehouse for other reporting scenarios. In this case, you might want to include data from Finance and Operations in your data warehouse.

- **You want to integrate with an external system.** An external system, such as a catalog or a quality management system, might require that you export master data from Finance and Operations into an external database.

- **You use a third-party analytical or reporting tool that requires Transact-SQL (T-SQL) access to data from Finance and Operations.** Because you don’t have direct access to the operational database, you might have to export the entities as required.

BYOD lets an IT administrator or a permitted user incrementally export entities into your own staging database or a data warehouse. BYOD takes advantage of DIXF in Finance and Operations. This functionality is incorporated into the Data management workspace.

The BYOD approach assumes that you’re familiar with data warehousing technologies. Here are some ways that BYOD helps reduce typical investments that are associated with building a custom data warehouse:

- **Over 1,700 ready-made entities in Finance and Operations let you extract data without having to rely on underlying table definitions.** Where ready-made entities don’t meet your requirements, you can extend them so that they include additional data fields.

- **Data management functionality lets you export data into your database via recurring batch jobs.** You can select either incremental push (especially for transaction tables) or full push.

- **Data projects let you manage updates of related entities together.** Therefore, data updates for periodic reporting jobs are consistent.

- **Change tracking functionality that is built into the data management framework lets you do incremental exports without having to manage the date stamps and update flags that are typically found in traditional data warehouse implementations.** As an administrator, you can select the granularity of change tracking. That is, you can specify when a change should be propagated to the destination.
As you saw earlier, Entity store is optimized for reporting on data that uses Power BI. BYOD is intended to be used to build data warehouse solutions. There are several functional differences between Entity store and BYOD:

- Entity store contains pre-joined star schemas that are modeled in Finance and Operations. These star schemas (or aggregate measurements) enable easy reporting via Power BI tools.
- BYOD stages entities as they appear in Finance and Operations. You must join them by using field relationships.
- Both Entity store and BYOD enable in-memory technologies to be used for reporting. If your destination database is a Microsoft Azure SQL database, BYOD can help you define CCIs to optimize query performance.

**Power BI solution templates**

Solution templates that are provided via AppSource lets your partners or IT staff extend the reports that power analytical workspaces, by including non-ERP data from other systems or data from IoT devices and sensors.

By using solution templates, in just a few minutes, you can set up an end-to-end solution that includes data extraction, Azure SQL Server database, Azure Analysis Services (optional), and ready-made Power BI reports. You can also extend the solution that is provisioned in your Azure subscription, so that it incorporates external data and business logic.

Ready-made reports that appear in analytical workspaces are available as solution templates. As opposed to building a custom data mart and developing content from scratch, you can extend the ready-made reports using your own data and reports.

If you're an ISV or a solution provider, you can package your own analytical workspaces into solution templates that appear in AppSource. Additionally, complete code samples that were used to package solution templates are freely available on GitHub. Therefore, you don’t have to spend your time designing and coding code to deploy, orchestrate, and integrate with Finance and Operations. Instead, you just have to package the ready-made solution.
Summary of options

The following illustration shows the scenarios and components that we discussed in this document.

Next steps: Resources for a deeper consideration

For more information about the Power BI content that is available in Finance and Operations, see Power BI content.

For a detailed overview of Entity store, together with a discussion of the schema, see Overview of the Power BI integration with Entity store.

For information about how to create Power BI reports by using Entity store, see Author analytical reports by using Power BI Desktop.

For a tutorial that walks you through the process of modeling aggregate data, see Modeling aggregate data.
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