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# Orchestration Best Practices in Microsoft Fabric

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Microsoft® Most Valuable Professional

Power BI kafíčko

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LINKEDIN

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# Agenda

## What I will be talking about

Why we should care about orchestrations

Schedulers

Power Automate / API

Pipeline

Orchestration of notebooks

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# Why we should care about orchestrations

alias… why we are here today

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# Coordination and Dependencies

## Coordination

**Coordination** is a process that ensures the **harmonious** and **efficient** cooperation of all parts of a system. It is essential for the **correct sequencing** of task execution. Without adequate coordination, errors and inefficient resource utilization may occur. Coordination involves **planning** and **managing** individual **steps** of the process, as well as handling **dependencies between tasks**. Within the medallion architecture, coordination is crucial for integrating data across different layers. It also includes the implementation of **failover scenarios** to ensure continuity.

# Coordination and Dependencies

## Dependencies

**Coordination** is a process that ensures the **harmonious** and **efficient** cooperation of all parts of a system. It is essential for the **correct sequencing** of task execution. Without adequate coordination, errors and inefficient resource utilization may occur. Coordination involves **planning** and **managing** individual **steps** of the process, as well as handling **dependencies between tasks**. Within the medallion architecture, coordination is crucial for integrating data across different layers. It also includes the implementation of **failover scenarios** to ensure continuity.

**Dependencies** in a pipeline are essential for ensuring the **correct order** and **coordination** of individual tasks. Each task in the pipeline may depend on other tasks, which means that some tasks must be completed before others can begin. Dependencies determine the execution **order** of tasks. If multiple tasks depend on the same preceding task, the pipeline must efficiently resolve these conflicts and ensure proper execution of all dependent tasks. Proper dependency management can significantly improve pipeline performance by **minimizing wait times** and maximizing resource utilization.

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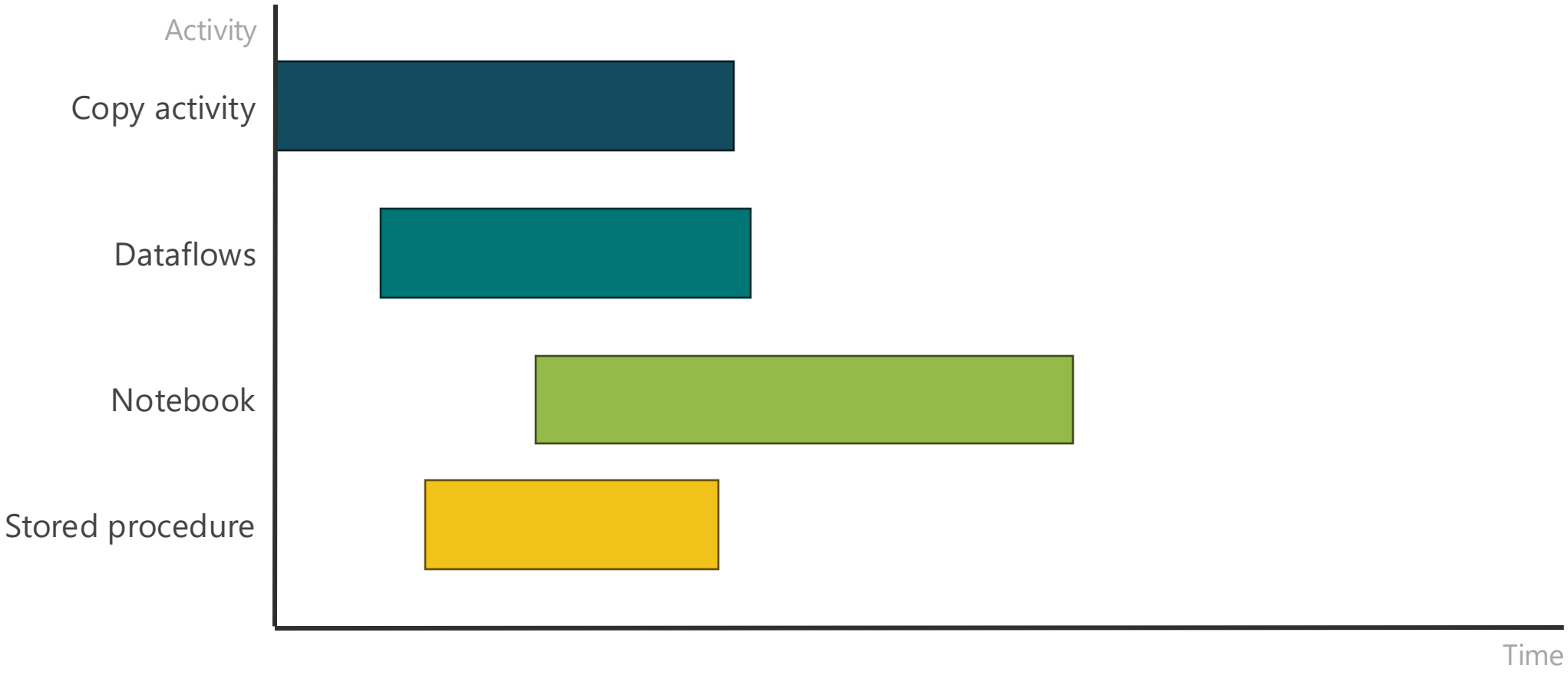
# Coordination and Dependencies

## How to handle timing

**Timing** is crucial for ensuring the **correct order** and scheduling of individual steps.

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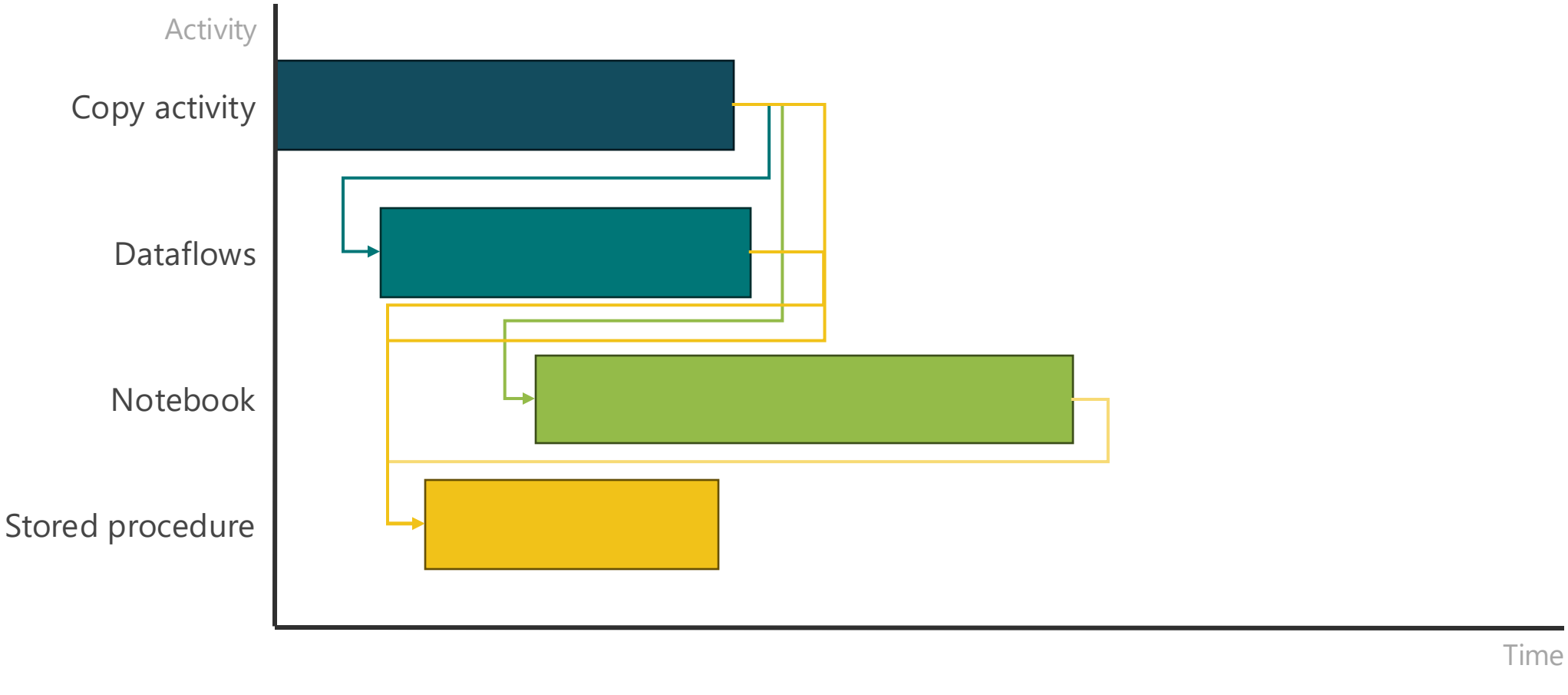
# Coordination and Dependencies

Disharmony can occur immediately when the timing is not correct.

**Timing** is crucial for ensuring the **correct order** and scheduling of individual steps.

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# Coordination and Dependencies

## Harmonization

**Timing** is crucial for ensuring the **correct order** and scheduling of individual steps.


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# Global paralilism of executed items

## How many items can be executed at one time?

- If they fit within the capacity… = not a fixed number
  - Semantic Model
  - Dataflow
  - Pipeline
  - Python Notebooks
  - …
- Strictly limited number depending on purchased capacity
  - PySpark, Spark (Scala), R, HTML Notebooks -> Depends on the number of available sessions

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# Restriction of global parallelism of PySpark Notebooks

and this can cause a lot of issues

| Fabric capacity SKU | Equivalent Power BI SKU | Spark VCores | Max Spark VCores with Burst Factor | Queue limit |
|---|---|---|---|---|
| F2 | - | 4 | 20 | 4 |
| F4 | - | 8 | 24 | 4 |
| F8 | - | 16 | 48 | 8 |
| F16 | - | 32 | 96 | 16 |
| F32 | - | 64 | 192 | 32 |
| F64 | P1 | 128 | 384 | 64 |
| F128 | P2 | 256 | 768 | 128 |
| F256 | P3 | 512 | 1536 | 256 |
| F512 | P4 | 1024 | 3072 | 512 |
| F1024 | - | 2048 | 6144 | 1024 |
| F2048 | - | 4096 | 12288 | 2048 |
| Trial Capacity | P1 | 128 | 128 | NA |

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# On-Demand request vs. Triggered request

## How is it counted, and into what?

If a Fabric item is started through the UI or via the REST API, it is executed as an *On-Demand request*. These requests can only be started **if there is currently available capacity**. For notebooks, this often results in the following error:

```
HTTP Response code 430: This Spark job can't be run because you have hit a Spark compute or API rate limit. To run this Spark job, cancel an active Spark job through the Monitoring hub, or choose a larger capacity SKU or try again later.
```

However, if a Fabric item is started through a scheduler or from an already running activity, it is executed as a *Triggered request*. These requests can be placed into a queue (provided there is space, according to the mentioned limit), from which they will be executed as soon as capacity becomes available.

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# Local paralelisation of executed item

wait… what? Can something be running multiple times at once?

- 1 item = 1 active instance *(0 instances in queue)*
  - Semantic Model
  - Dataflow
  - Pipeline
  - Data stream
- 1 item = 1 active instance *(X instances in queue)*
  - Pipeline
  - Python Notebooks
  - PySpark, Spark (Scala), R, HTML Notebooks

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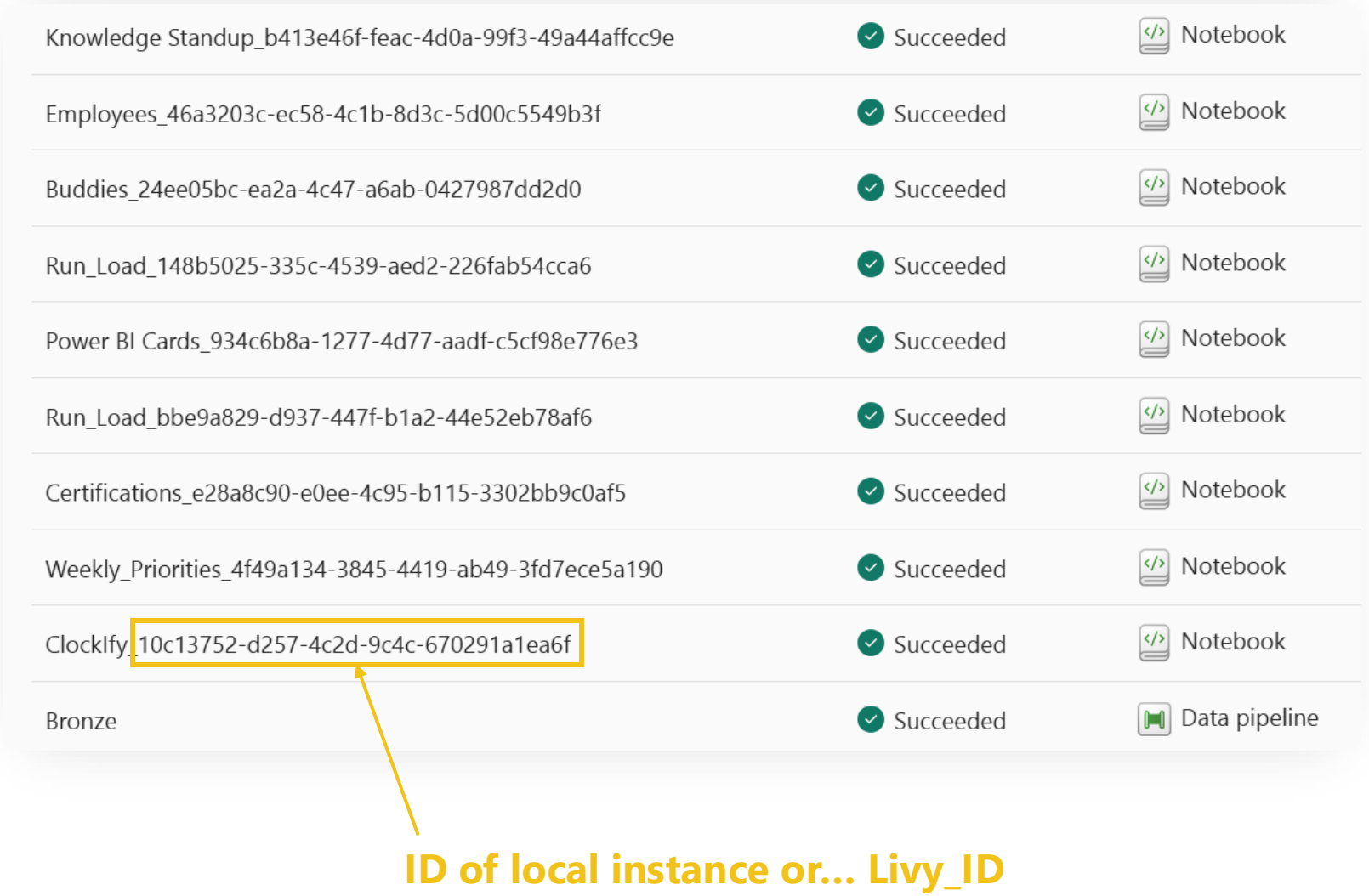
# Local paralelisation of executed item

wait… what? Can something be running multiple times at once?

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# High Concurrency Sessions

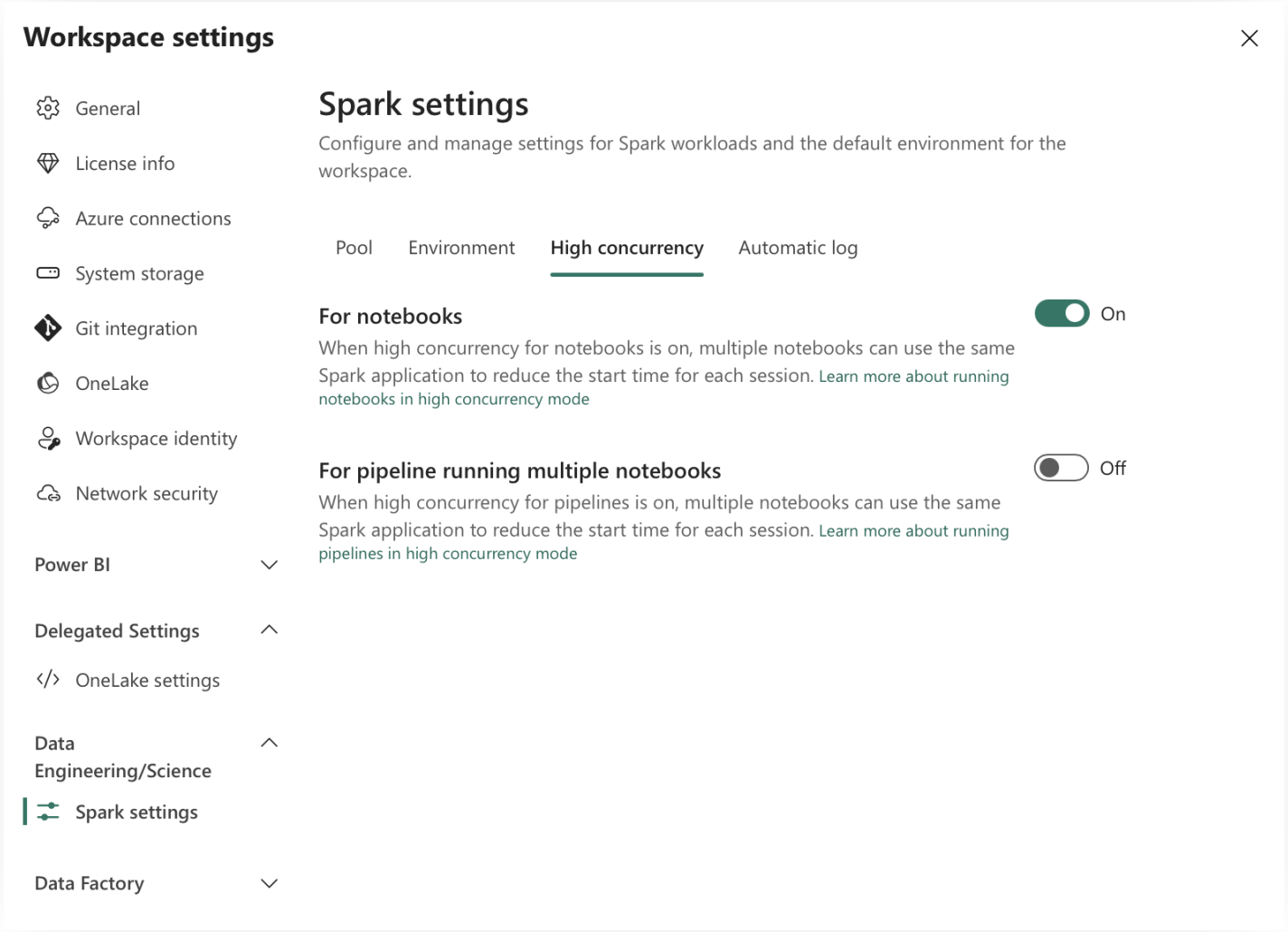
## As a means of sharing resources of a single session for notebooks

They allow sharing a session across multiple notebooks simultaneously. This is very useful when we want to be considerate of other users and processes. To enable session sharing, the following rules from the documentation must be followed:

- The notebooks must use the **same default Lakehouse**,
- they must use the **same Spark configuration**,
- they must use the **same libraries (i.e., environment)** – additional libraries can then be installed within the notebook

# High Concurrency Sessions

As a means of sharing resources of a single session for notebooks

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# Schedulers

Native option for timers. But are they reliable?

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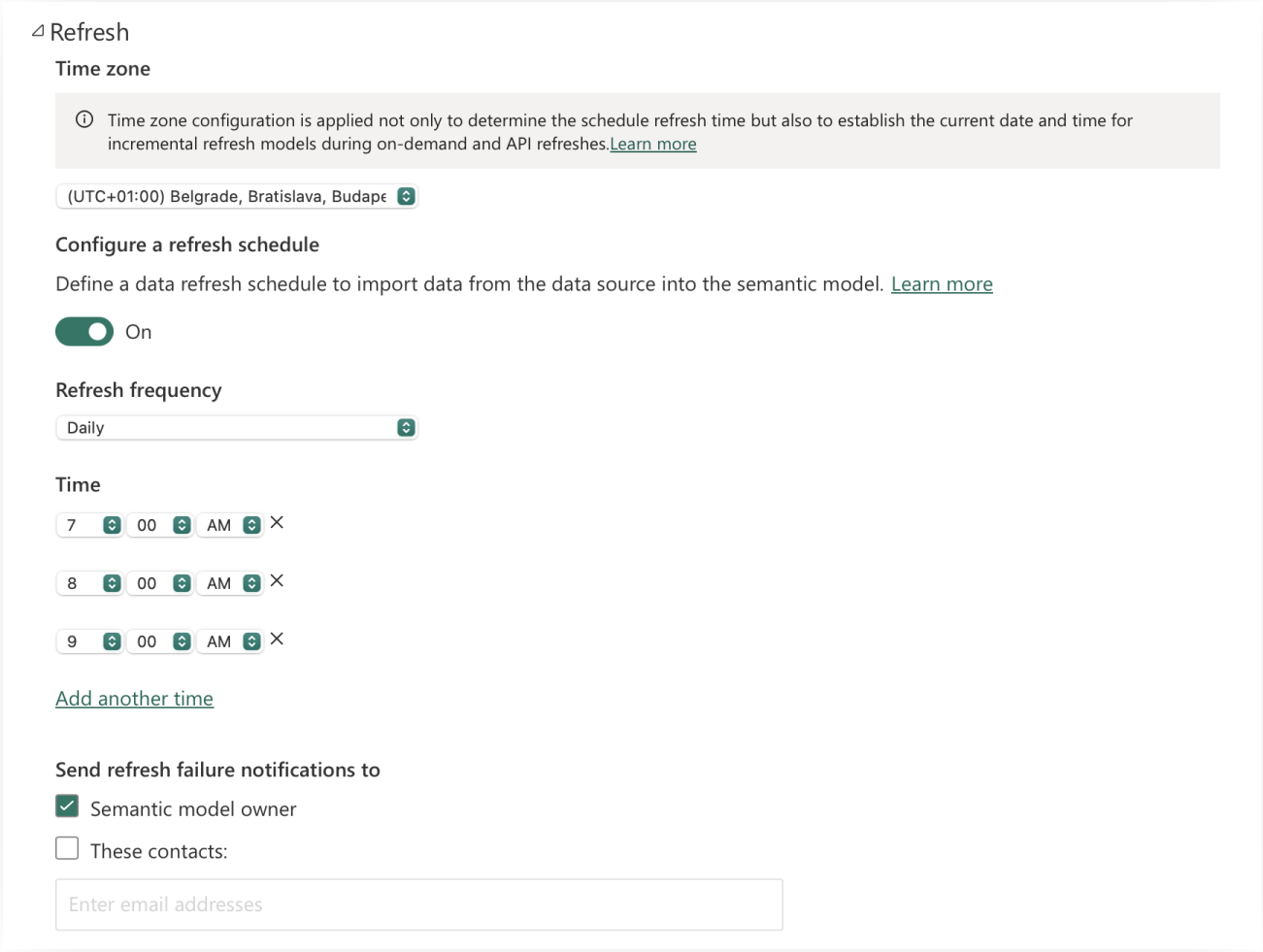
# Semantic Models

A simple timer allowing execution 8× to 48× per day (depending on the license).

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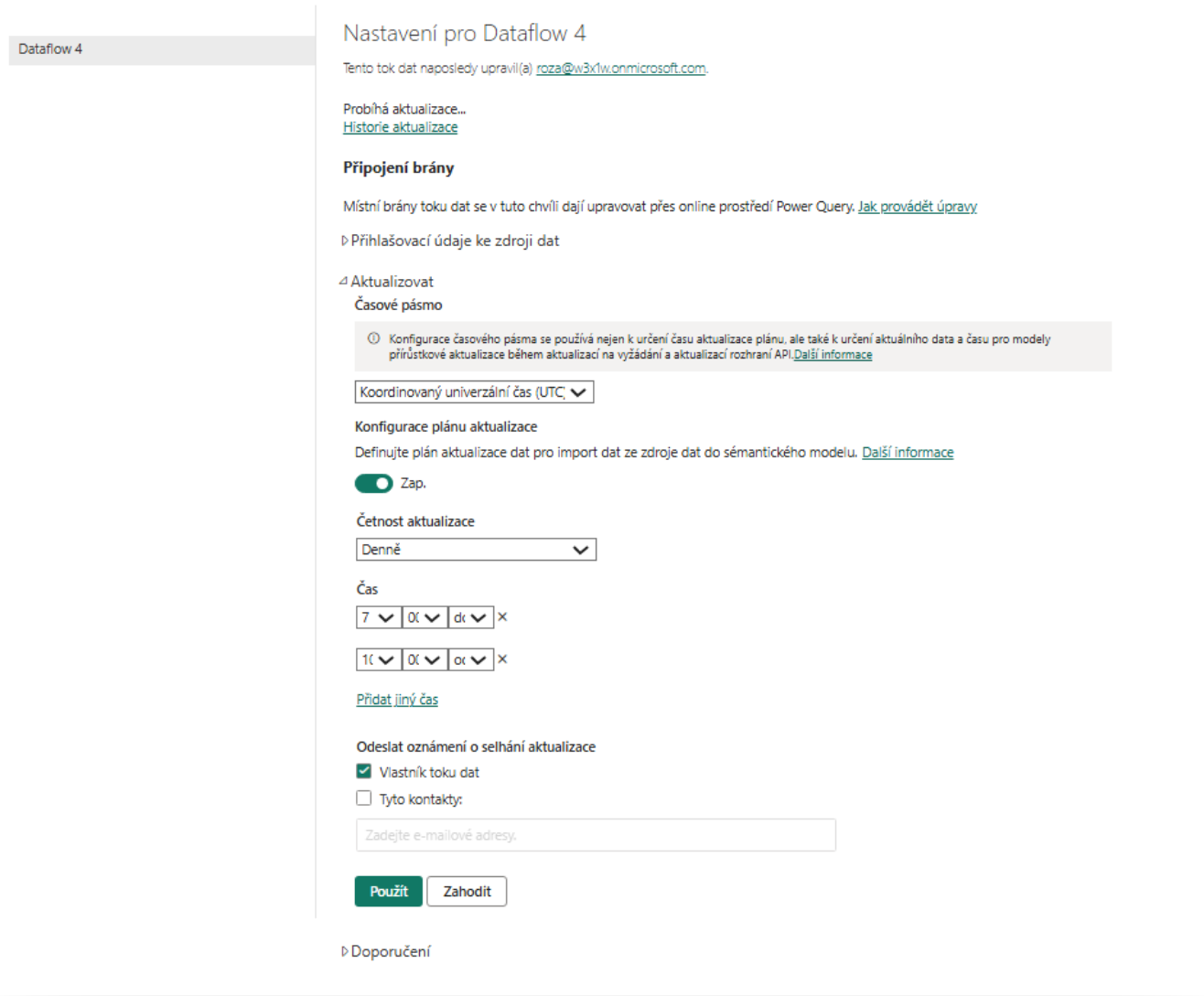
# Dataflows

## Does this mean it will run exactly at the specified time?

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# Timing

How does the timing for these schedulers work?


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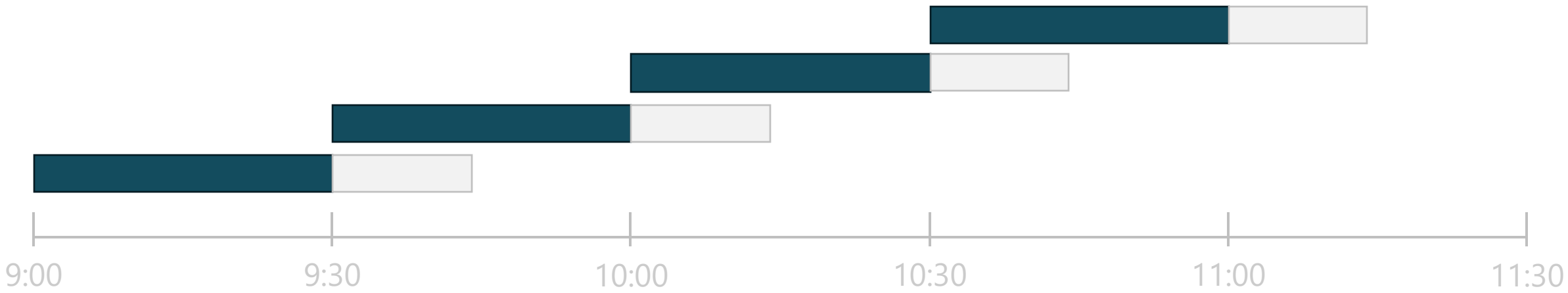
How does the timing for these schedulers work?

Refresh time: **9:00**

Refresh time: **9:30**

Refresh time: **10:00**

Refresh time: **10:30**

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# Timing

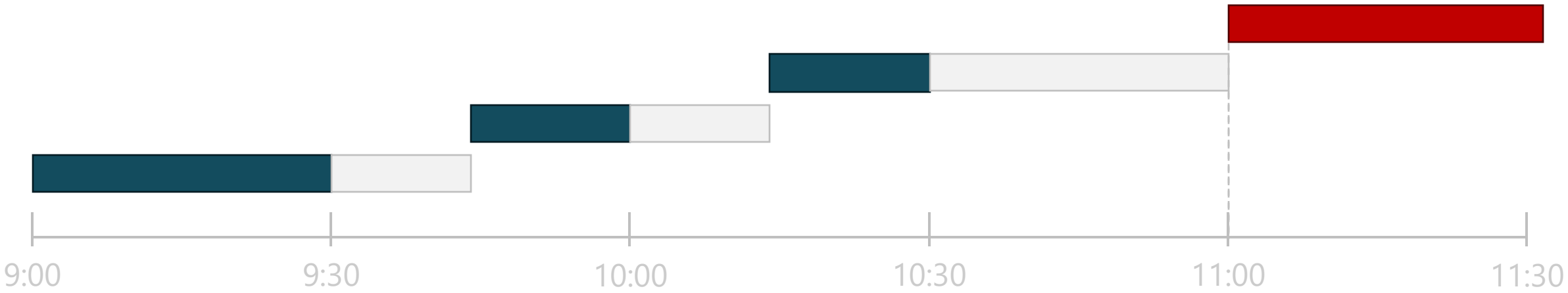
How does the timing for these schedulers work?

Refresh time: **9:00**

Refresh time: **9:30**

Refresh time: **10:00** *(Refresh was longer then expected)*

Refresh time: **10:30** *(Skipped)*

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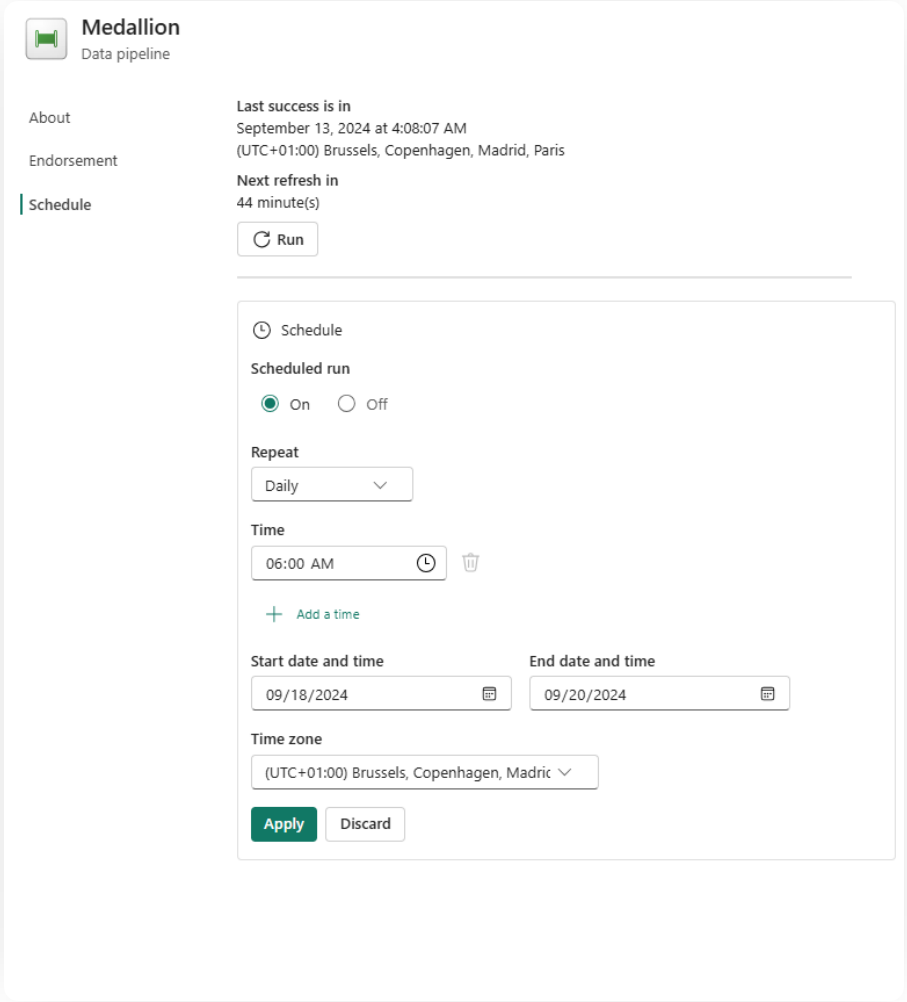
# Data Pipeline

It also has a scheduler, but a different one…

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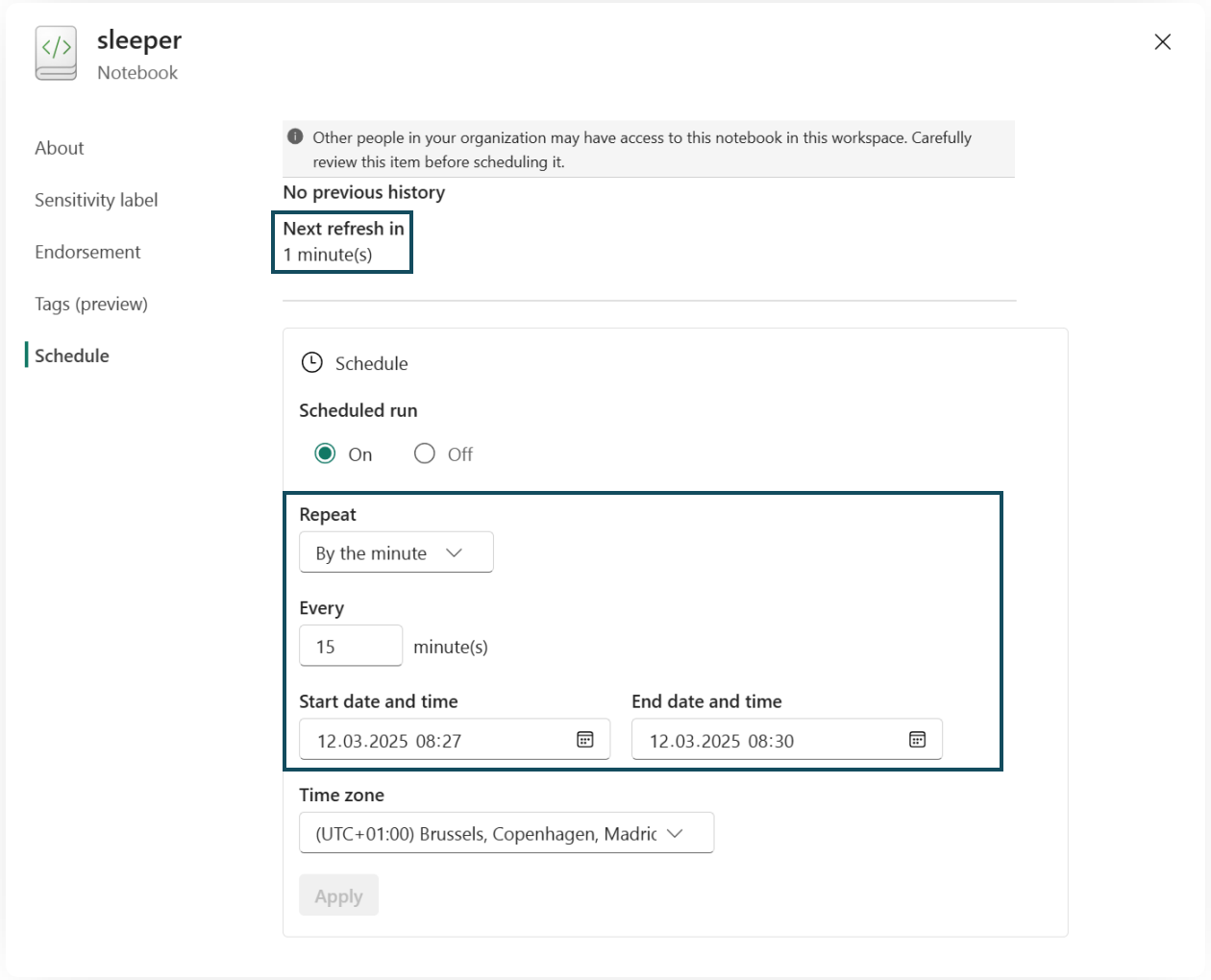
# Notebook

But what if I were executing a notebook that will run longer than the timeframe for the next trigger




```
1  import time
```

```
1  time.sleep(120)
```

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# Notebook

They will be inserted into the queue

| Activity name | Status | Item type | Start time | Submitted by | Location |
|---|---|---|---|---|---|
| sleeper | Not started | Notebook | 03/12/2025, 8:29 AM | Štěpán Rešl | [T] Štěpán - AppInNotebookDemo |
| sleeper | Not started | Notebook | 03/12/2025, 8:28 AM | Štěpán Rešl | [T] Štěpán - AppInNotebookDemo |
| sleeper_5ca8ca67-bf50-4b7f-b48f-607805f2e37d | In progress | Notebook | 03/12/2025, 8:27 AM | Štěpán Rešl | [T] Štěpán - AppInNotebookDemo |

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# Power Automate / API

When we need an exact update time in cases where the scheduler is not sufficient.

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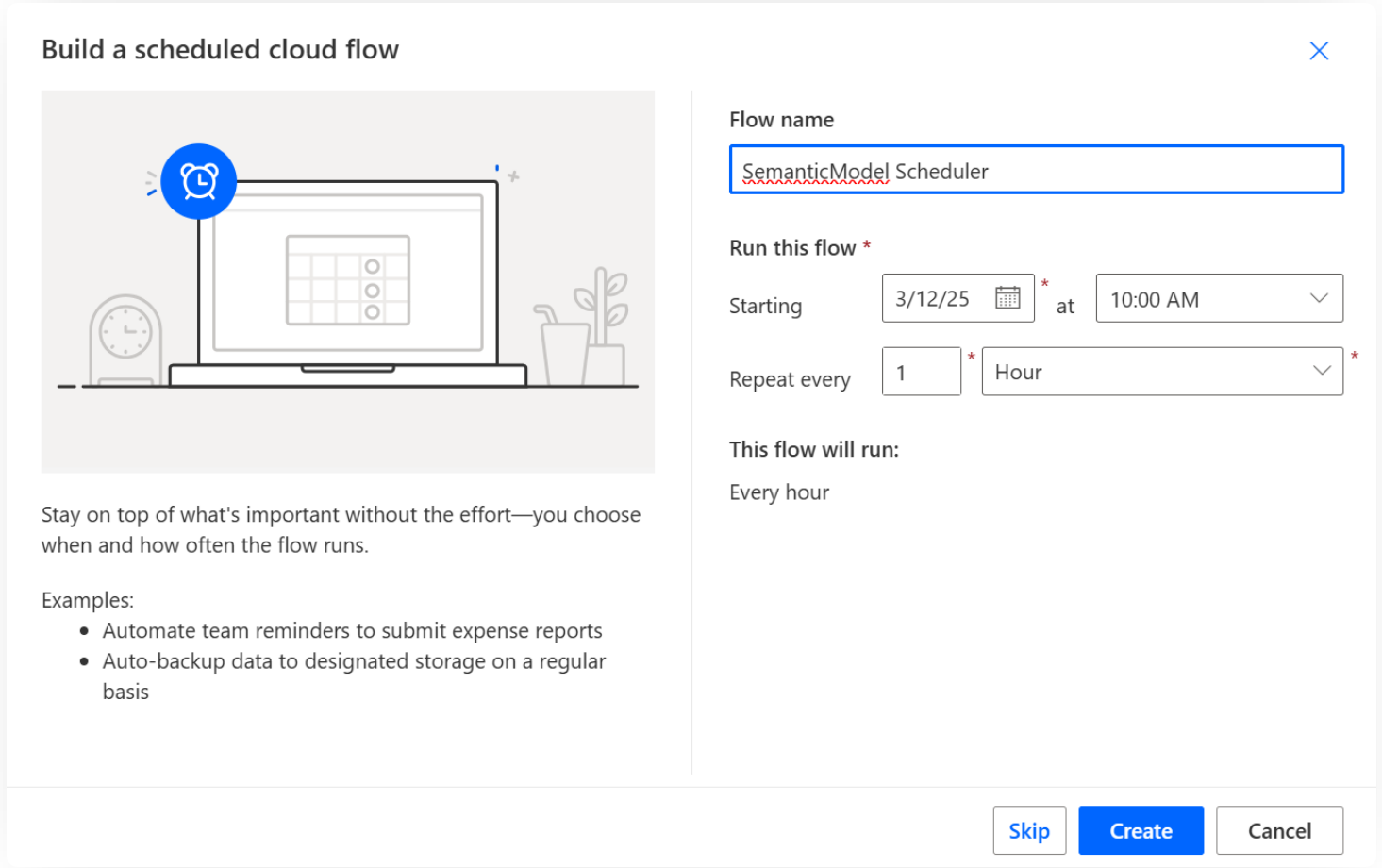
# Power Automate

## Custom scheduler... (it also supports executing every minute, but... don't trust it...)

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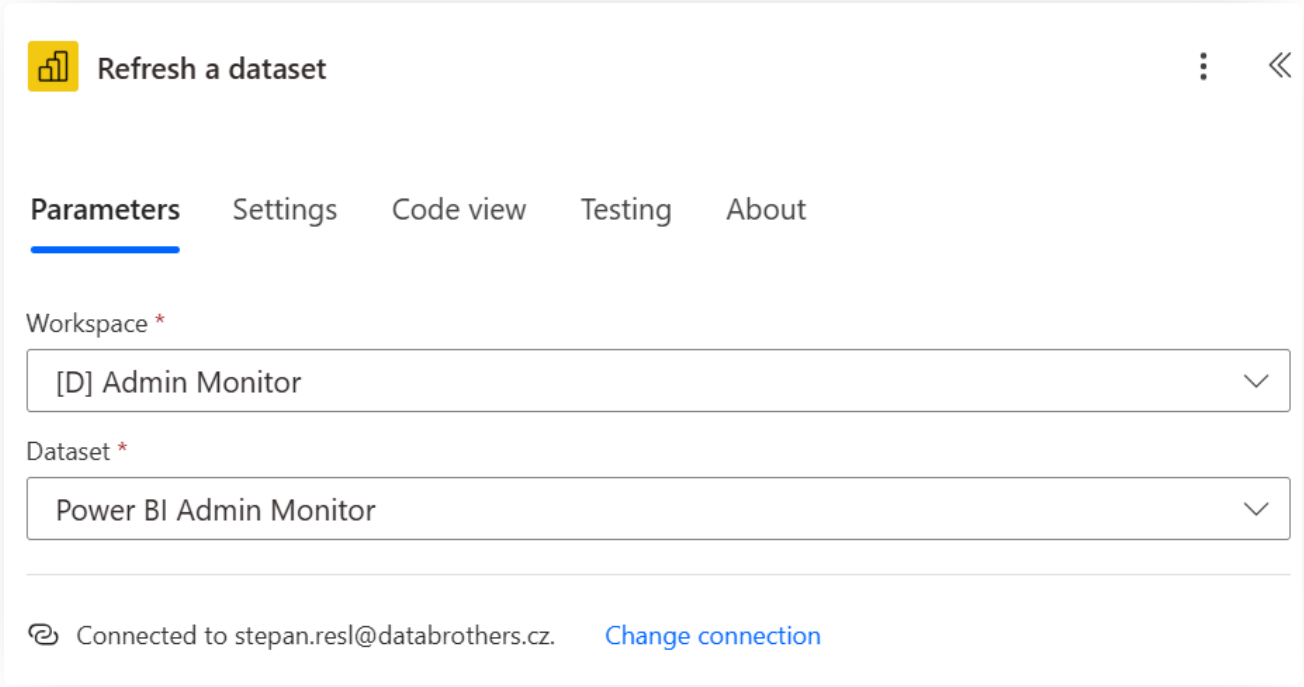
# Power Automate

Pre-created action for refreshing a semantic model under your connection.

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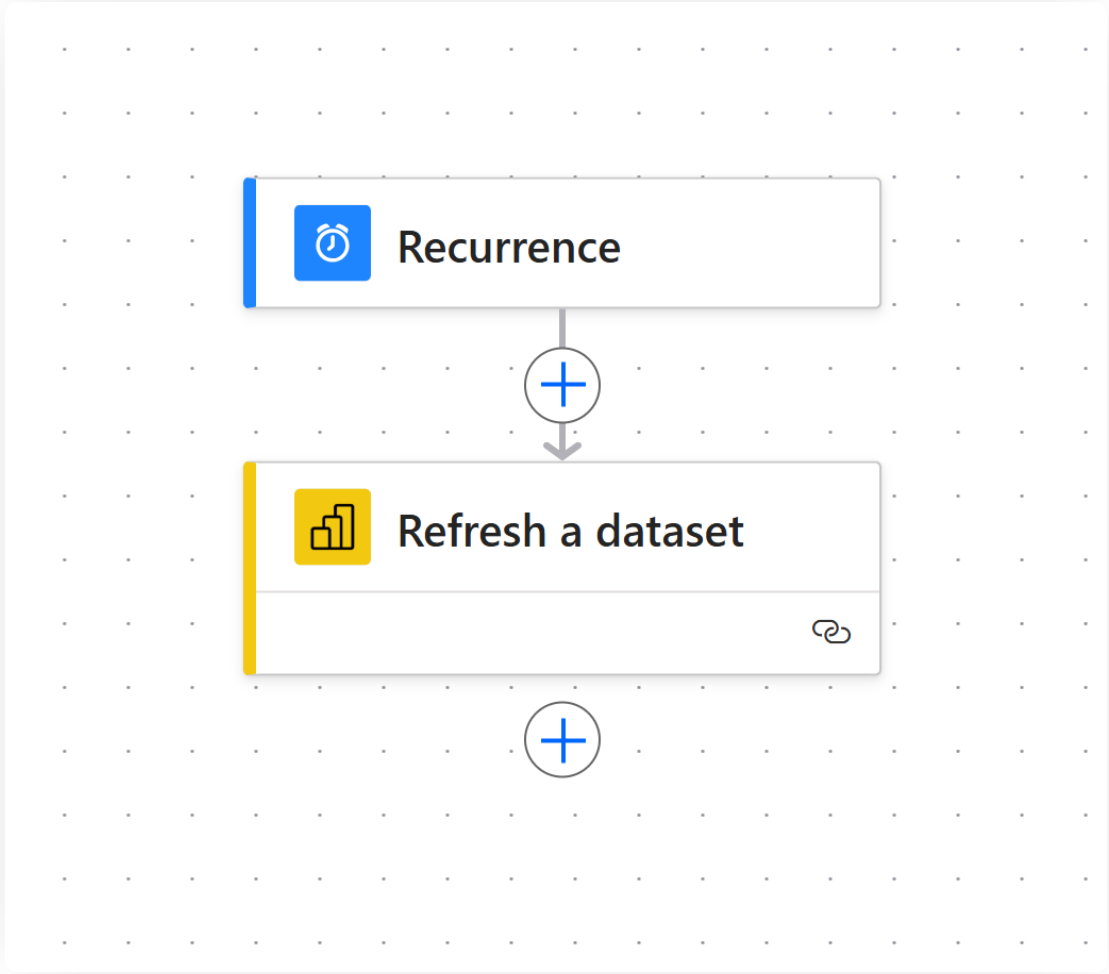
# Power Automate

Trivial run of scheduler...

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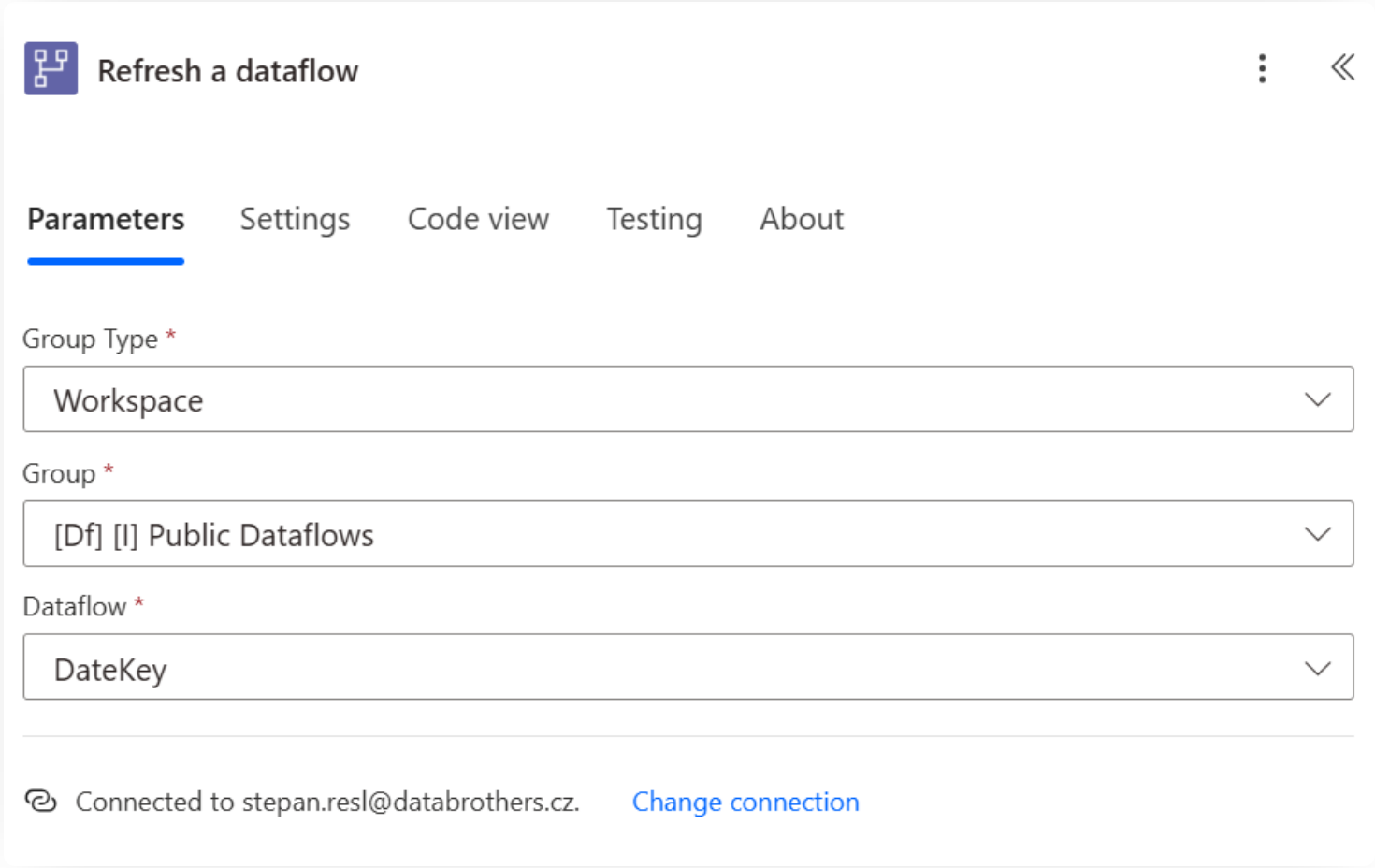
# Power Automate

The same works here for the Dataflows...

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# API

In other words, when the native features in Power Automate or the scheduler options are not sufficient…

- POST https://api.powerbi.com/v1.0/myorg/groups/{groupId}/datasets/{datasetId}/refreshes
- POST https://api.powerbi.com/v1.0/myorg/groups/{groupId}/dataflows/{dataflowId}/refreshes

---

- POST https://api.fabric.microsoft.com/v1/workspaces/{groupId}/items/{itemId}/jobs/instances?jobType=RunNotebook
- POST https://api.fabric.microsoft.com/v1/workspaces/{groupId}/items/{itemId}/jobs/instances?jobType=Pipeline
- …

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# Refresh Dataset in Group

An API that enables much more than one might expect.

- POST https://api.powerbi.com/v1.0/myorg/groups/{groupId}/datasets/{datasetId}/refreshes
- Authorization: User, Service Principal *(Dataset.ReadWrite.All)*

| Name | Required | Type | Description |
|---|---|---|---|
| notifyOption | True | Notify Option | Mail notification options. This parameter is not applicable to enhanced refreshes or API operations with a service principal. |
| applyRefreshPolicy | | boolean | Determine if the policy is applied or not |
| commitMode | | Dataset Commit Mode | Determines if objects will be committed in batches or only when complete |
| effectiveDate | | string | If an incremental refresh policy is applied, the `effectiveDate` parameter overrides the current date. |
| maxParallelism | | integer | The maximum number of threads on which to run parallel processing commands |
| objects | | Dataset Refresh Objects[] | An array of objects to be processed |
| retryCount | | integer | Number of times the operation will retry before failing. Temporary internal errors may trigger a retry of the refresh, even when this parameter is set to 0. |
| timeout | | string | If a `timeout` is specified, each data refresh attempt on the semantic model will adhere to that timeout. Note that a single refresh request can include multiple attempts if `retryCount` is specified, which may cause the total refresh duration to exceed the specified timeout. For instance, setting a `timeout` of 1 hour with a `retryCount` of 2 could result in a total refresh duration of up to 3 hours. Users can adjust the `timeout` to shorten the refresh duration for faster failure detection or extend it beyond the default 5 hours for more complex data refreshes. However, the total refresh duration, including retries, cannot exceed 24 hours. |
| type | | Dataset Refresh Type | The type of processing to perform |

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# Refresh Dataset in Group

An API that enables much more than one might expect.

```
{
        "type": "full",
        "commitMode": "transactional",
        "objects": [
                { "table": "Customer", "partition": "Robert" }
        ],
        "applyRefreshPolicy": "false",
        "timeout": "05:00:00"
}
```

| Name | Type | Description |
|---|---|---|
| Automatic | string | If the object needs to be refreshed and recalculated, refresh and recalculate the object and all its dependents. Applies if the partition is in a state other than Ready. |
| Calculate | string | Recalculate this object and all its dependents, but only if needed. This value doesn't force recalculation, except for volatile formulas. |
| ClearValues | string | Clear values in this object and all its dependents |
| DataOnly | string | Refresh data in this object and clear all dependents |
| Defragment | string | Defragment the data in the specified table. As data is added to or removed from a table, the dictionaries of each column can become polluted with values that no longer exist in the actual column values. The defragment option will clean up the values in the dictionaries that are no longer used. |
| Full | string | For all partitions in the specified partition, table, or database, refresh data and recalculate all dependents. For a calculation partition, recalculate the partition and all its dependents. |

| Name | Type | Description |
|---|---|---|
| PartialBatch | string | Commit the refresh operation in batches. When utilizing `partialBatch` mode, the refresh operation does not occur within a transaction. Consequently, each command will be committed individually, and in the event of a failure, the model may end up in a state where only a subset of the data is loaded, or the table is left empty. If you desire to guarantee the preservation of previous data in case of a failure, you should execute the operation with `commitMode = transactional.` |
| Transactional | string | Commit the whole refresh operation as a transaction |

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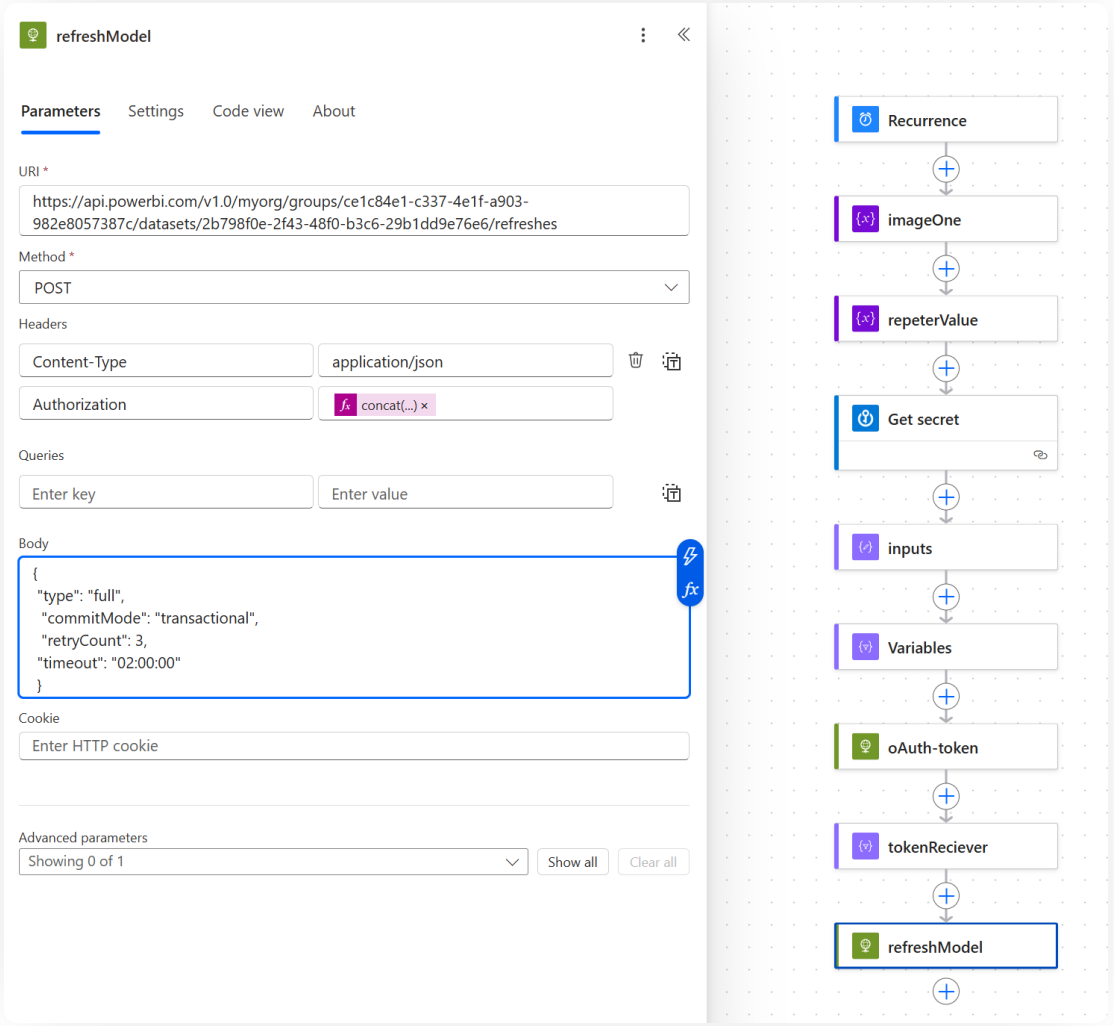
# Power Automate + REST API

## And suddenly, it's possible to run exactly what we need!

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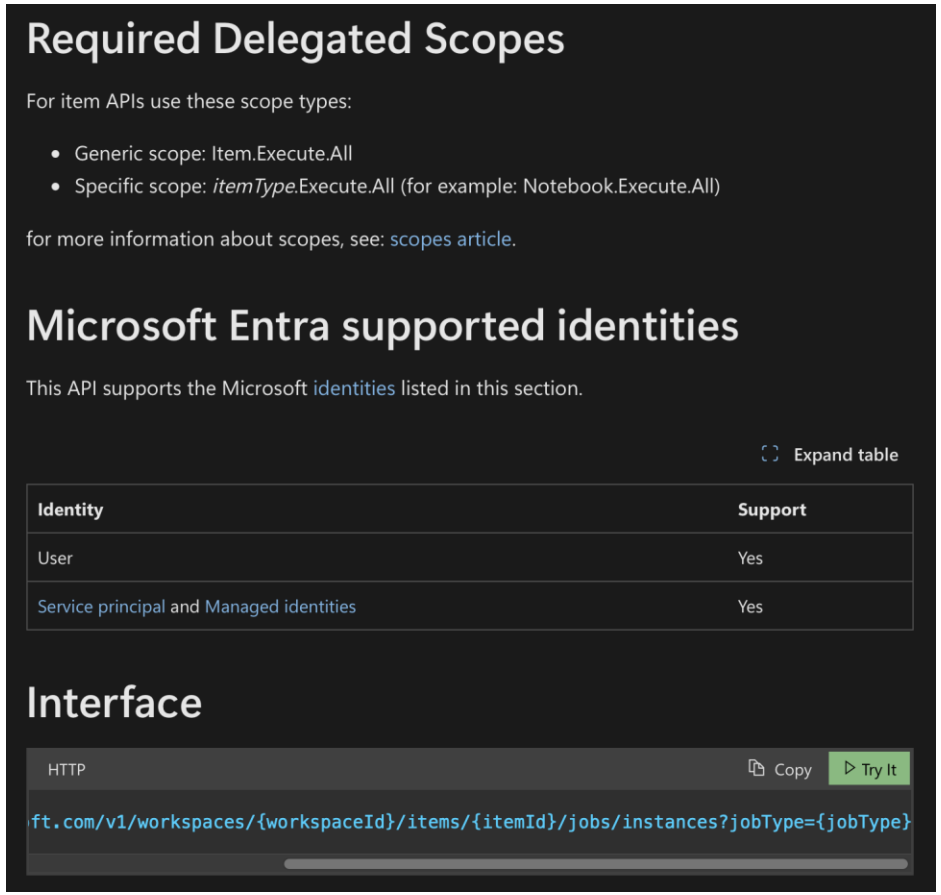
# Execute Fabric Notebook

An API that enables much more than one might expect.

- POST https://api.fabric.microsoft.com/v1/workspaces/{groupId}/items/{itemId}/jobs/instances?jobType=RunNotebook
- Authorization: User, Service Principal



## Required Delegated Scopes

For item APIs use these scope types:

- Generic scope: Item.Execute.All
- Specific scope: *itemType*.Execute.All (for example: Notebook.Execute.All)

for more information about scopes, see: scopes article.

## Microsoft Entra supported identities

This API supports the Microsoft identities listed in this section.

Expand table

| Identity | Support |
|---|---|
| User | Yes |
| Service principal and Managed identities | Yes |

## Interface

HTTP Copy Try It

ft.com/v1/workspaces/{workspaceId}/items/{itemId}/jobs/instances?jobType={jobType}

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# Pipeline

From Azure Data Factory to Azure Synapse, all the way to Microsoft Fabric

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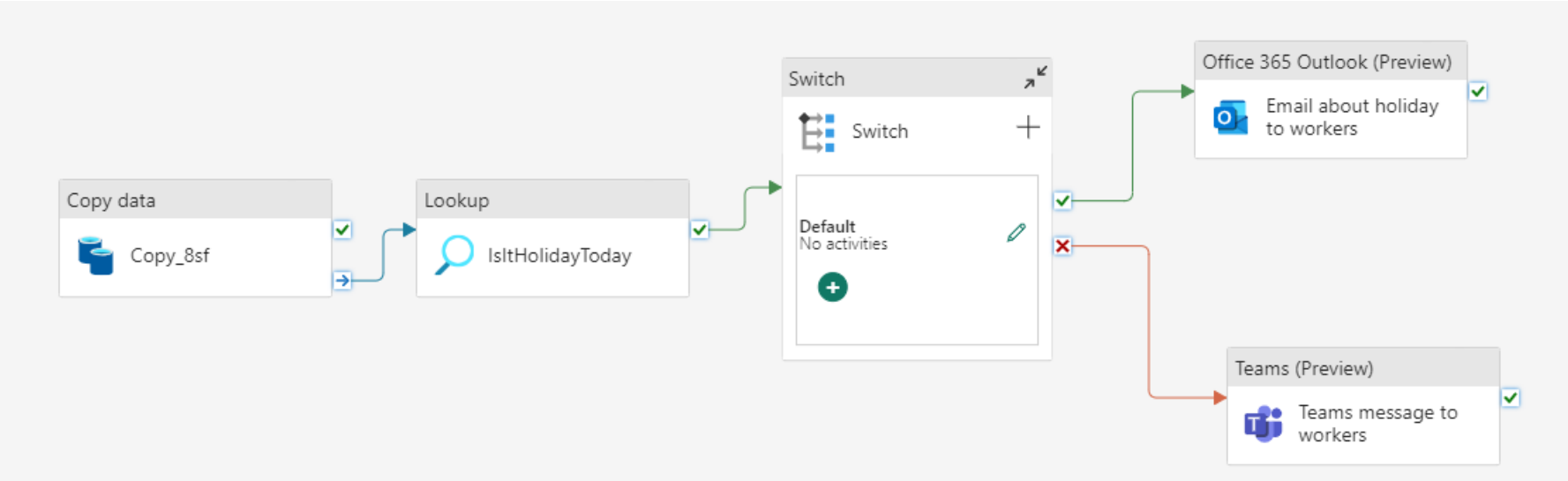
# Data Pipeline

## Short recapitulation

A Data Pipeline functions as an **orchestration component** that can trigger other items and services, and it can be scheduled to run at a specific time.

**Activities** are executable tasks within a Pipeline. You can define the flow of activities by linking them in **sequence**. **The outcome** of a particular activity (success, failure, or completion) can then be used to **direct the flow** to the next activity in the sequence.

A data pipeline enables the combination of various operations within a single framework and executes them over time as part of a unified process.

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# Data Pipeline

Bins of activities

| Data movement activities | Data transformation activities | Control flow activities |
| --- | --- | --- |
| **Used to transfer data from point A to point B.** It leverages Azure Data Movement Services. | **Used for data transformations.** These activities can be parameterized within the pipeline, allowing control over what is transformed and when. | **Used to control the pipeline flow,** i.e., "what should happen when." |

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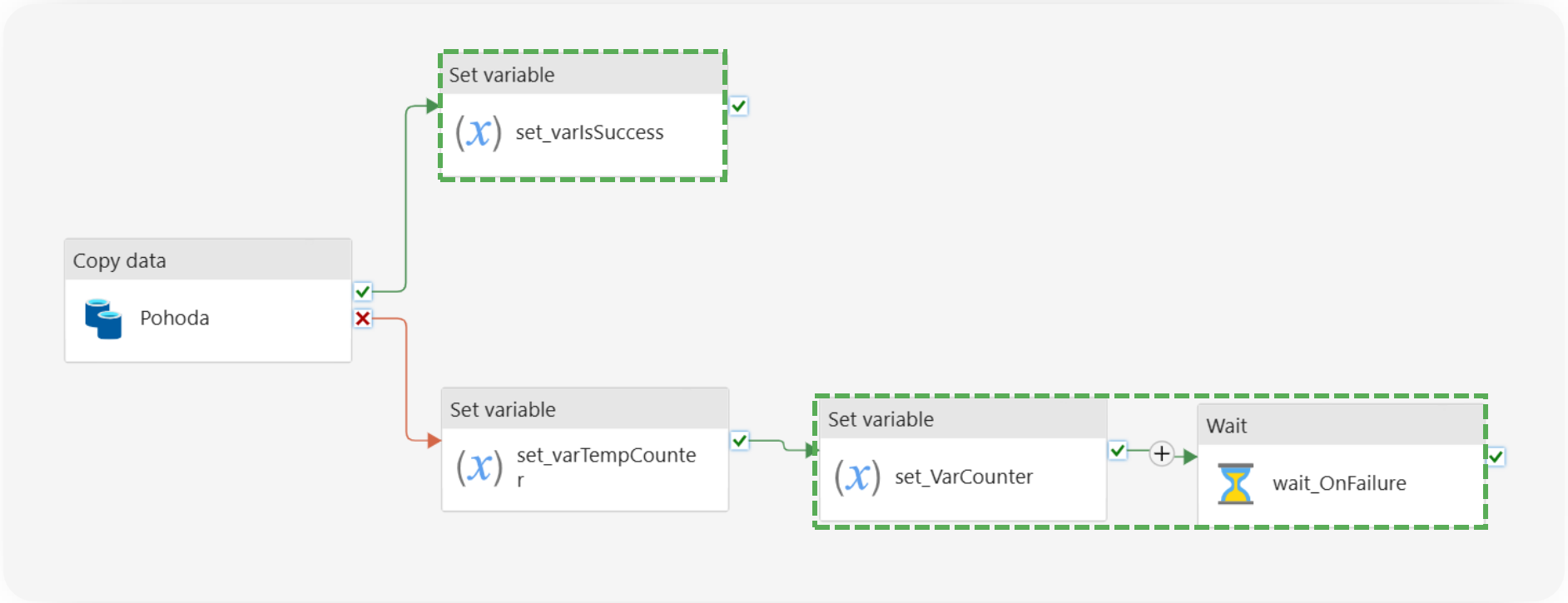
# Coordination and consequences

## Consequences - On Success

**On Success** is triggered when an activity completes successfully.

It is used to define the next steps in the pipeline that should occur **only if the preceding activity was successful**. For example, after successfully copying data, you may proceed with transforming it.

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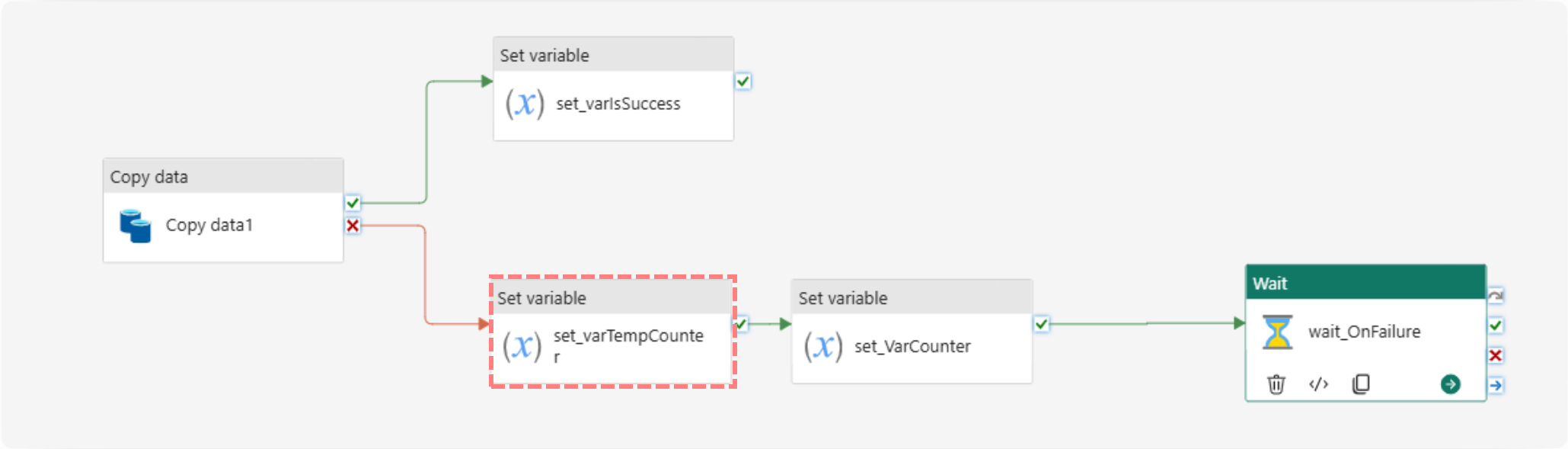
# Coordination and consequences

## Návaznost - On Fail

**On Failure** is triggered when an activity fails.
It is used for error handling and defining alternative actions when an activity does not complete as expected. This may include logging the error, sending a notification, or triggering another set of activities to handle the failure.

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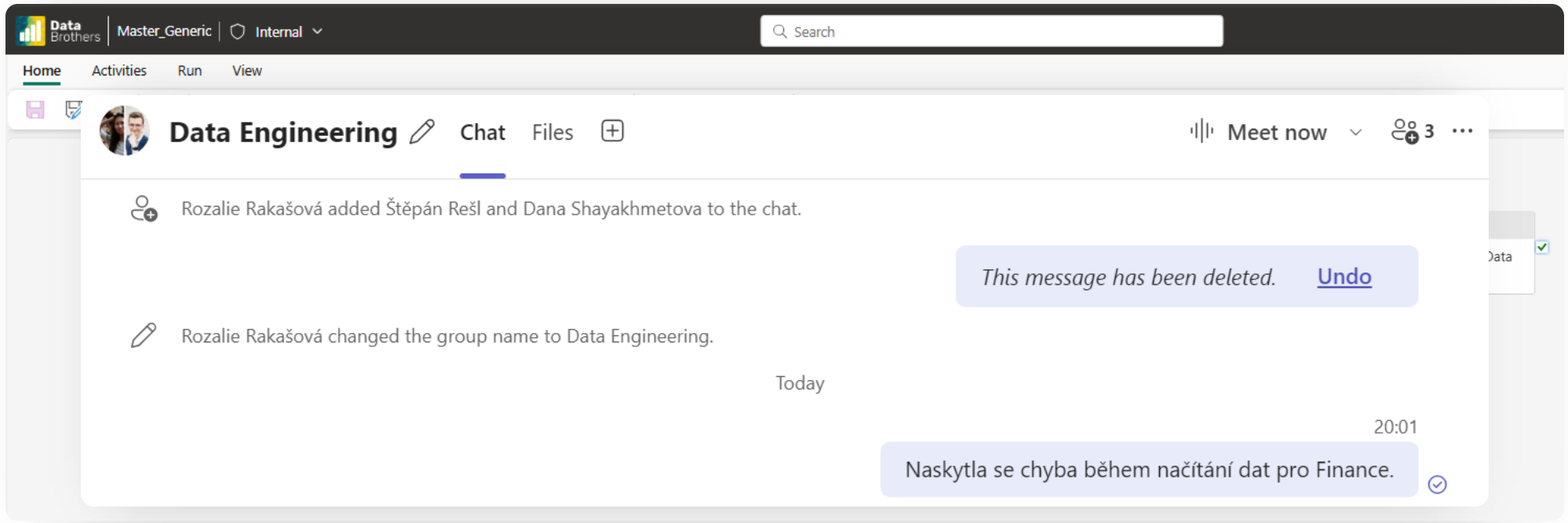
# Coordination and consequences

## Zaslání notifikace

In the event of an operation failure, it is possible to configure notifications to be sent to an email address or **Microsoft Teams**.
By utilizing dynamic content from helper variables and filters, you can send information about the specific error source, eliminating the need to review all sources to locate the error.

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# Coordination and consequences

Creating a variable that will containresult status of activites.

```
@createArray(
    concat(
        'Bronze | ',
        activity('Bronze').Status
    ),
    concat(
        'Silver | ',
        activity('Silver').Status
    ),
    concat(
        'Gold | ',
        activity('Gold').Status
    )
)
```

**Výstup:**

Bronz | Failed
Silver | Failed
Gold | Failed

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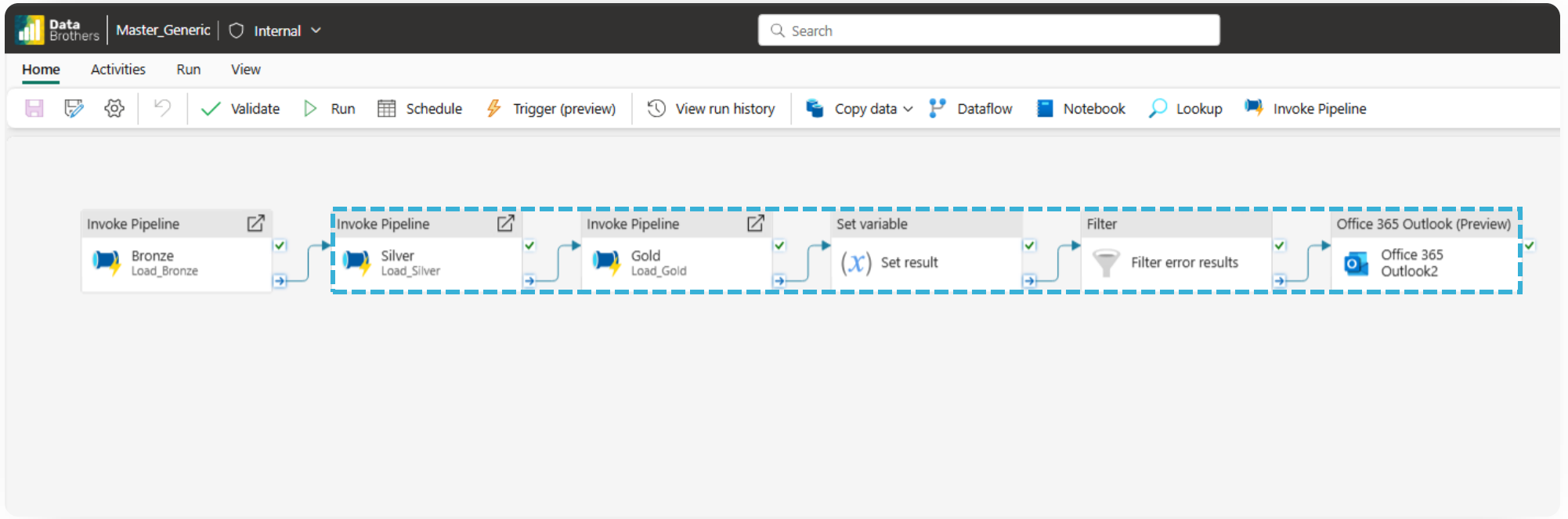
# Coordination and consequences

## Consequences - On Completion

**On Completion** is triggered when an activity finishes, regardless of whether it succeeded or failed.
It is used to define steps that should follow after the previous activity has finished, no matter the outcome (e.g., after a data copy step completes—whether successfully or with an error—perform cleanup operations or log the result).
However, it does not include the **On Skip** condition.

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# Coordination and consequences

## Consequences - On Skip

**On Skip** is triggered when an activity is skipped.
This can happen due to conditional logic in the pipeline that determines the activity is not needed.
It can be useful in scenarios where certain steps are required only under specific conditions. For example, if a data source is empty, you may skip the data transformation step.

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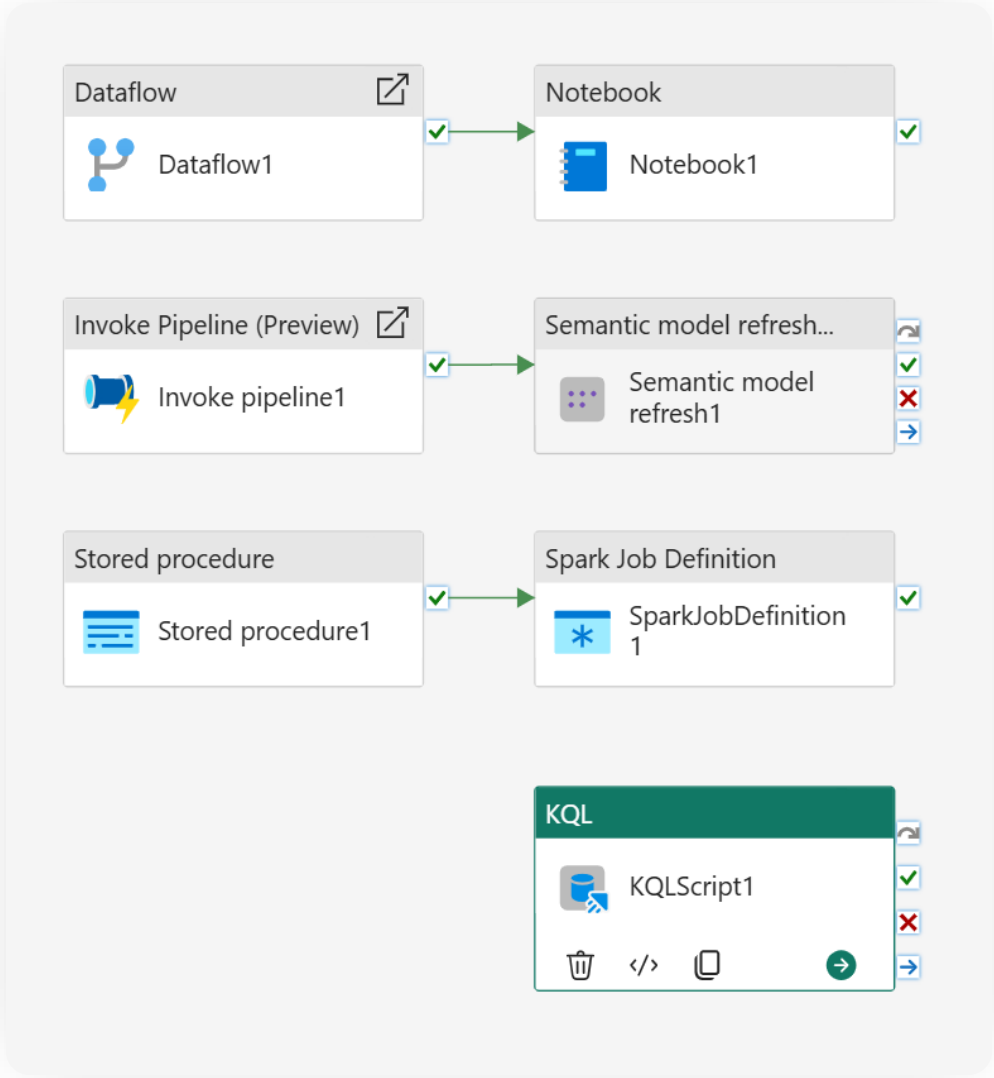
# Coordination and consequences

Invoke of… almost anything…

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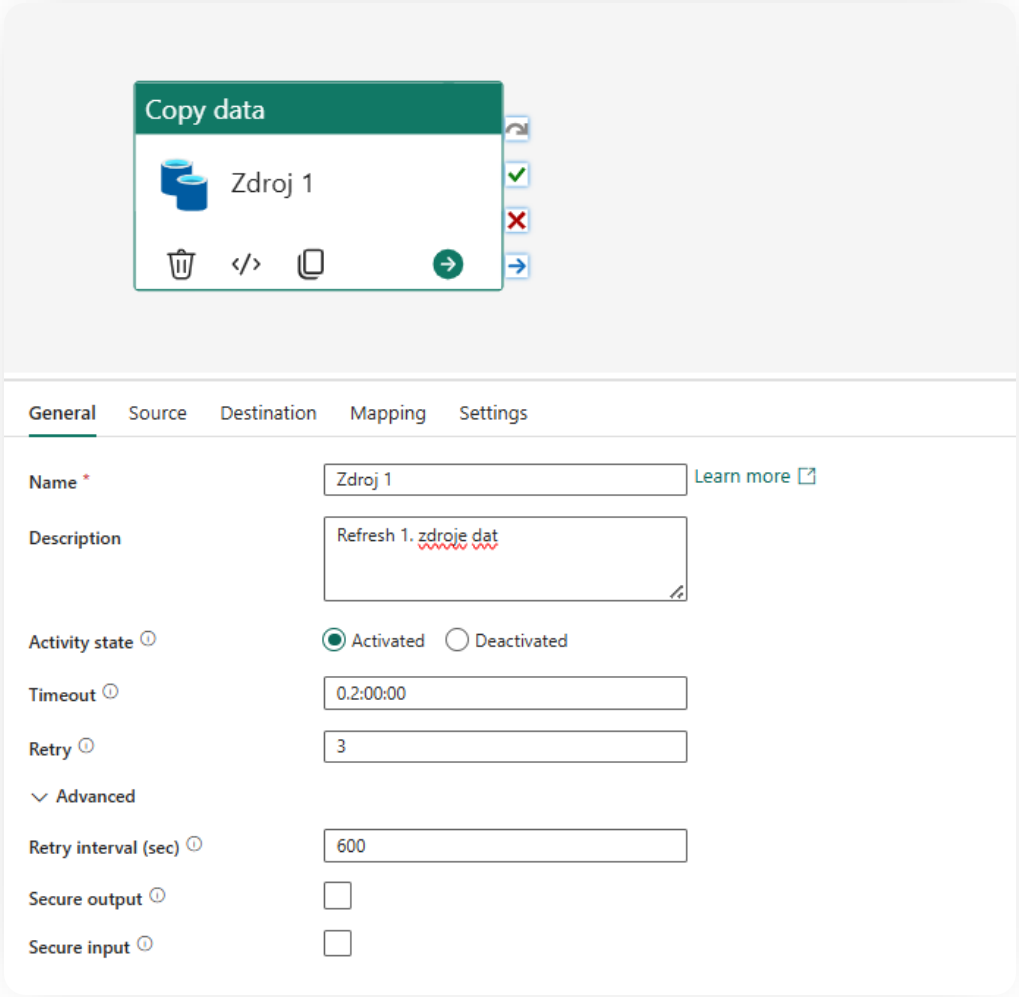
# Coordination and consequences

## Specification of actions

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# Orchestration of notebooks

Directed Acyclic Graph (DAG). POZOR! Neplést s DAX!

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# %run magic command

## But before the DAG arrives, the wizard appears…

This is one of the ways to have one notebook trigger another. Unfortunately, it is not a very transparent method of running notebooks, as in many cases, you may want to run multiple notebooks in a specific order due to dependencies. This approach requires placing the triggering code in each of the notebooks, which leads to the mentioned lack of clarity. Moreover, this variant only supports up to **5 levels of nesting**. As soon as a fifth notebook attempts to trigger another one, an error will be returned.

Within this execution, however, all resources are shared, because no actual separate notebook run occurs — instead, its code is injected into the current one. This means that if the included notebook contains libraries or variables, these will also be transferred into the calling notebook and may cause conflicts or overwrite existing variables. In short, this creates a very high probability of collisions.

```
%run [-b/--builtin -c/--current] [script_file.py/.sql] [variables ...]
```

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# notebookutils.notebook

And this wizard has quite a few more tricks up his sleeve.

The most important helpers for optimal notebook orchestration:

```
notebookutils.notebook.run("notebook name", <timeoutSeconds>, <parameterMap>, <workspaceId>)
```

```
notebookutils.notebook.runMultiple(<DAG>, <config>)
```

When a notebook is triggered, **a new session is not created**! Everything runs under the existing session of the notebook that initiated the execution, and the workload is “only” redistributed across available nodes within the active session.

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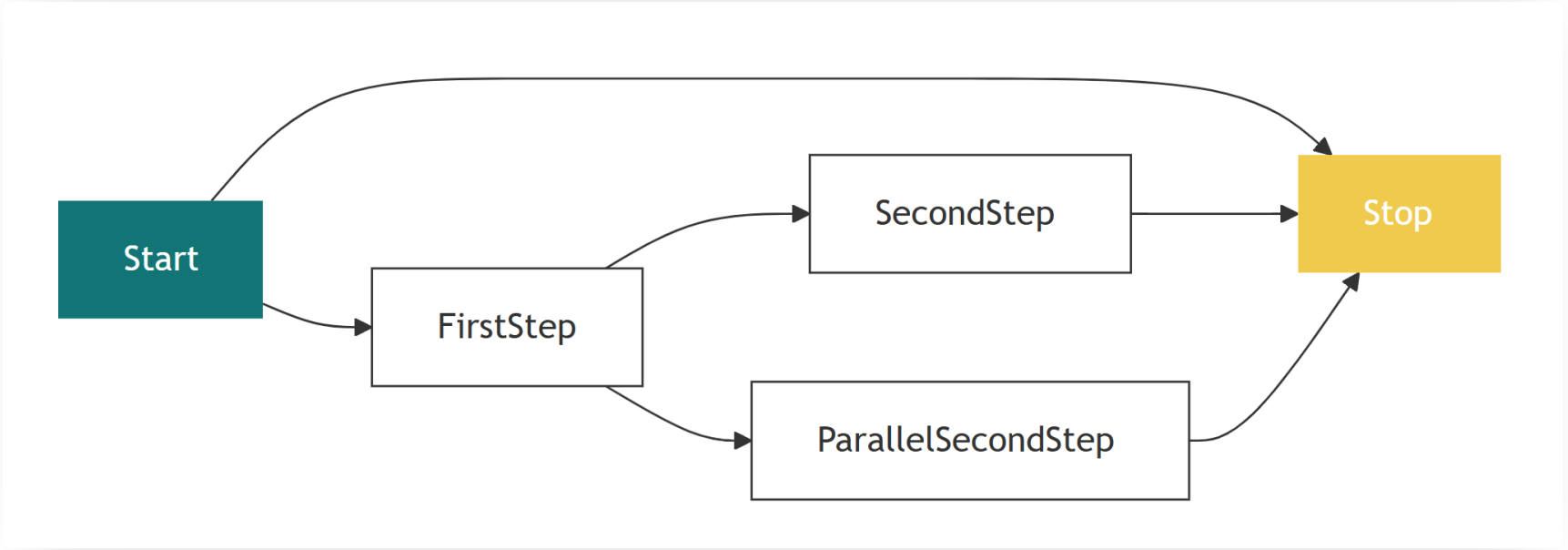
# Showcase of DAG

Illustration for better understanding

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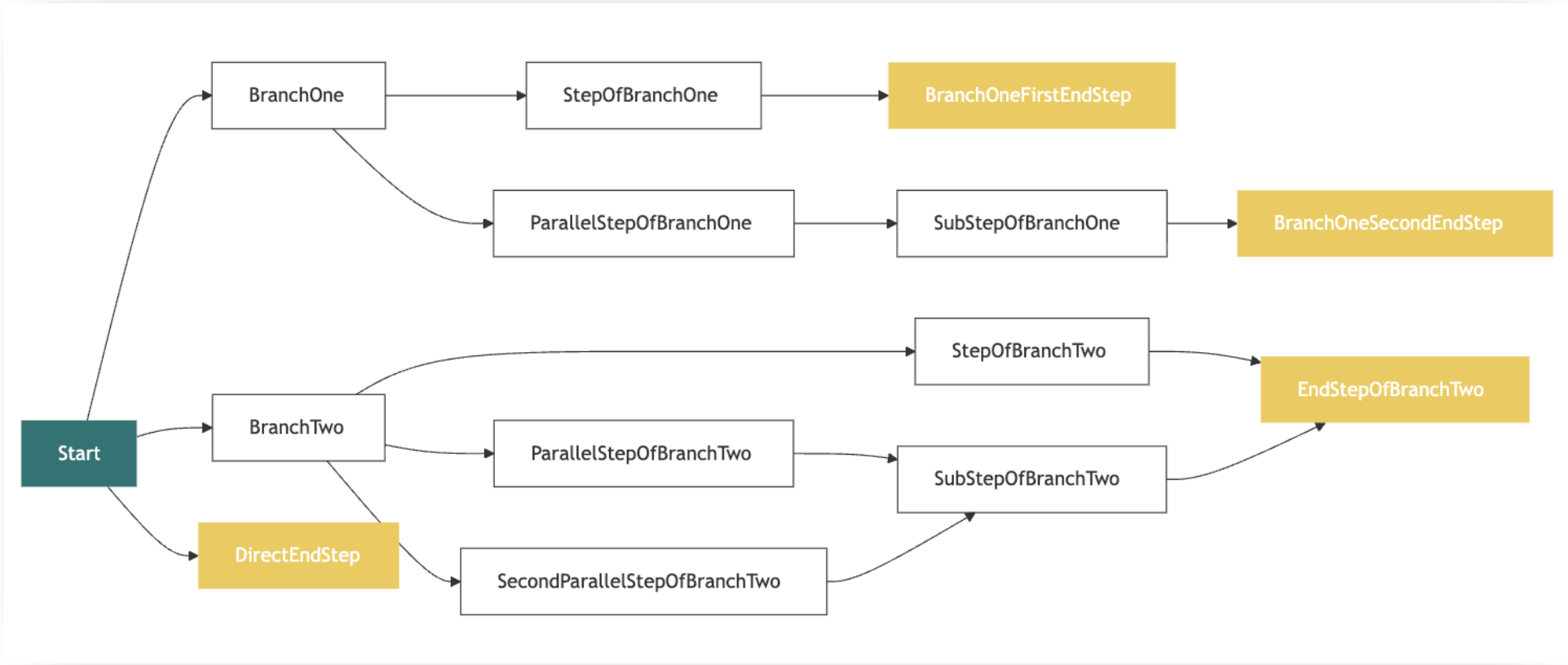
# Showcase of DAG

Illustration for better understanding

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# Supported definition of DAG

## And this is how we write it down...

```
DAG = {
    "activities": [
        {
            "name": "notebook1", # activity name, must be unique
            "path": "notebook1", # notebook path
            "timeoutPerCellInSeconds": 90, # max timeout for each cell, default to 90 seconds
            "args": {"param1": "value1"}, # notebook parameters
            "workspace": "workspace1", # workspace name, default to current workspace
            "retry": 0, # max retry times, default to 0
            "retryIntervalInSeconds": 0, # retry interval, default to 0 seconds
            "dependencies": [] # list of activity names that this activity depends on
        },
        {
            "name": "notebook2",
            "path": "notebook2",
            "timeoutPerCellInSeconds": 120,
            "args": {
                "useRootDefaultLakehouse": True, # set useRootDefaultLakehouse as True
                "param1": "@activity('notebook1').exitValue()" # use exit value of notebook1
            },
            # to ignore that child notebook attach a different default lakehouse.
            "retry": 1,
            "retryIntervalInSeconds": 10,
            "dependencies": ["notebook1"]
        }
    ],
    "timeoutInSeconds": 43200, # max timeout for the entire pipeline, default to 12 hours
    "concurrency": 50 # max number of notebooks to run concurrently, default to 50, 0 means unlimited
}

notebookutils.notebook.runMultiple(DAG, {"displayDAGViaGraphviz": False, "showArgs": False, "showTime": False})
```

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# Supported definition of DAG

## Example of implementation

```
silver_load_flow_dag = {
    "activities":[
        {"name": "Load_To_Silver_Apps","path":"Load_To_Silver_Apps", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Capacities","path":"Load_To_Silver_Capacities", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Domains","path":"Load_To_Silver_Domains", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Links","path":"Load_To_Silver_Links", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Deployment_Pipelines","path":"Load_To_Silver_Deployment_Pipelines", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Fact_Link","path":"Load_To_Silver_Fact_Link", "timeoutPerCellInSeconds": 7200, "dependencies": ["Load_To_Silver_Links"]},
        {"name": "Load_To_Silver_Users","path":"Load_To_Silver_Users", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Gateways","path":"Load_To_Silver_Gateways", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Groups","path":"Load_To_Silver_Groups", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_GroupsUsers","path":"Load_To_Silver_GroupsUsers", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_UserLicenses","path":"Load_To_Silver_UserLicenses", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_ServicePrincipals","path":"Load_To_Silver_ServicePrincipals", "timeoutPerCellInSeconds": 600, "dependencies": []},
        {"name": "Load_To_Silver_Workspaces","path":"Load_To_Silver_Workspaces", "timeoutPerCellInSeconds": 600, "dependencies": ["Load_To_Silver_Capacities","Load_To_Silver_Domains"]},
        {"name": "Load_To_Silver_SensitivityLabels","path":"Load_To_Silver_SensitivityLabels", "timeoutPerCellInSeconds": 600, "dependencies": ["Load_To_Silver_Users","Load_To_Silver_Group
        {"name": "Load_To_Silver_Imports","path":"Load_To_Silver_Imports", "timeoutPerCellInSeconds": 600, "dependencies": ["Load_To_Silver_Subscriptions"]},
        {"name": "Load_To_Silver_ActivityEvents","path":"Load_To_Silver_ActivityEvents", "timeoutPerCellInSeconds": 3600, "dependencies": ["Load_To_Silver_Subscriptions"]},
        {"name": "Load_To_Silver_Subscriptions","path":"Load_To_Silver_Subscriptions", "timeoutPerCellInSeconds": 600, "dependencies": ["Load_To_Silver_Workspaces","Load_To_Silver_Sensitiv
        {"name": "Load_To_Silver_Datasources","path":"Load_To_Silver_Datasources", "timeoutPerCellInSeconds": 7200, "dependencies": ["Load_To_Silver_Users","Load_To_Silver_Groups"]},
        {"name": "Load_To_Silver_WS_Scanner","path":"Load_To_Silver_WS_Scanner", "timeoutPerCellInSeconds": 7200, "dependencies": ["Load_To_Silver_Datasources","Load_To_Silver_Users","Load
    ]
}
```

[21] PySpark (Python)

+ Code + Markdown

Run load for all notebooks to silver

```
notebookutils.notebook.runMultiple(silver_load_flow_dag, {"displayDAGViaGraphviz": False})
```

PySpark (Python)

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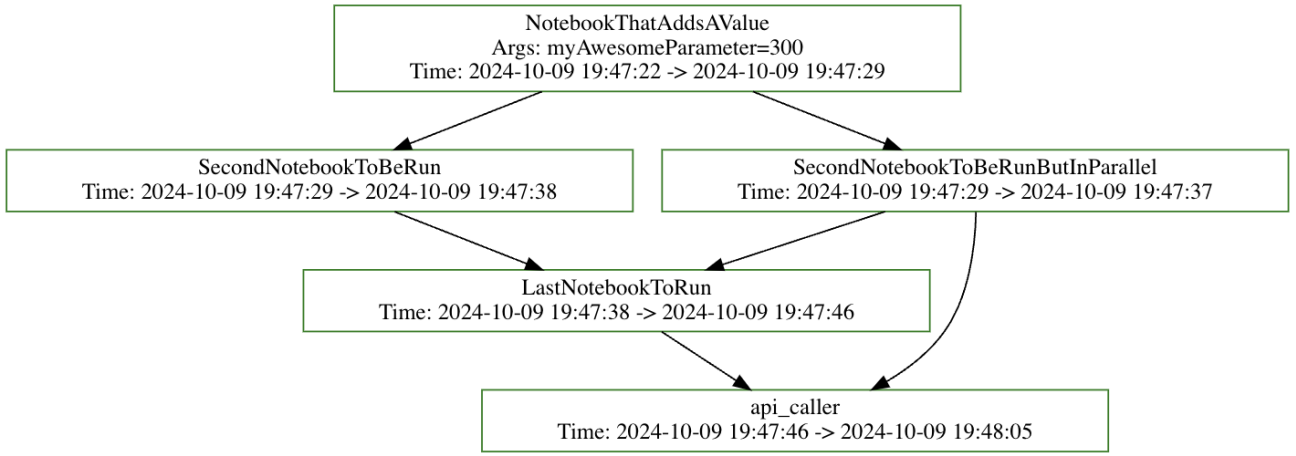
# Displayed DAG chart after execution

with a graphical chart addition…

| Activity name | Snapshot | Status | Progress | Duration | Exit value | Exception |
|---|---|---|---|---|---|---|
| NotebookThatAddsAValue | NotebookThatAddsAValue | Succeeded | 100% | 7 sec 561 ms | - | - |
| SecondNotebookToBeRun | SecondNotebookToBeRun | Succeeded | 100% | 8 sec 748 ms | - | - |
| SecondNotebookToBeRunButInParallel | SecondNotebookToBeRunButInParallel | Succeeded | 100% | 7 sec 545 ms | - | - |
| LastNotebookToRun | LastNotebookToRun | Succeeded | 100% | 7 sec 677 ms | Hurey!!! | - |
| api_caller | api_caller | Succeeded | 100% | 18 sec 724 ms | - | - |

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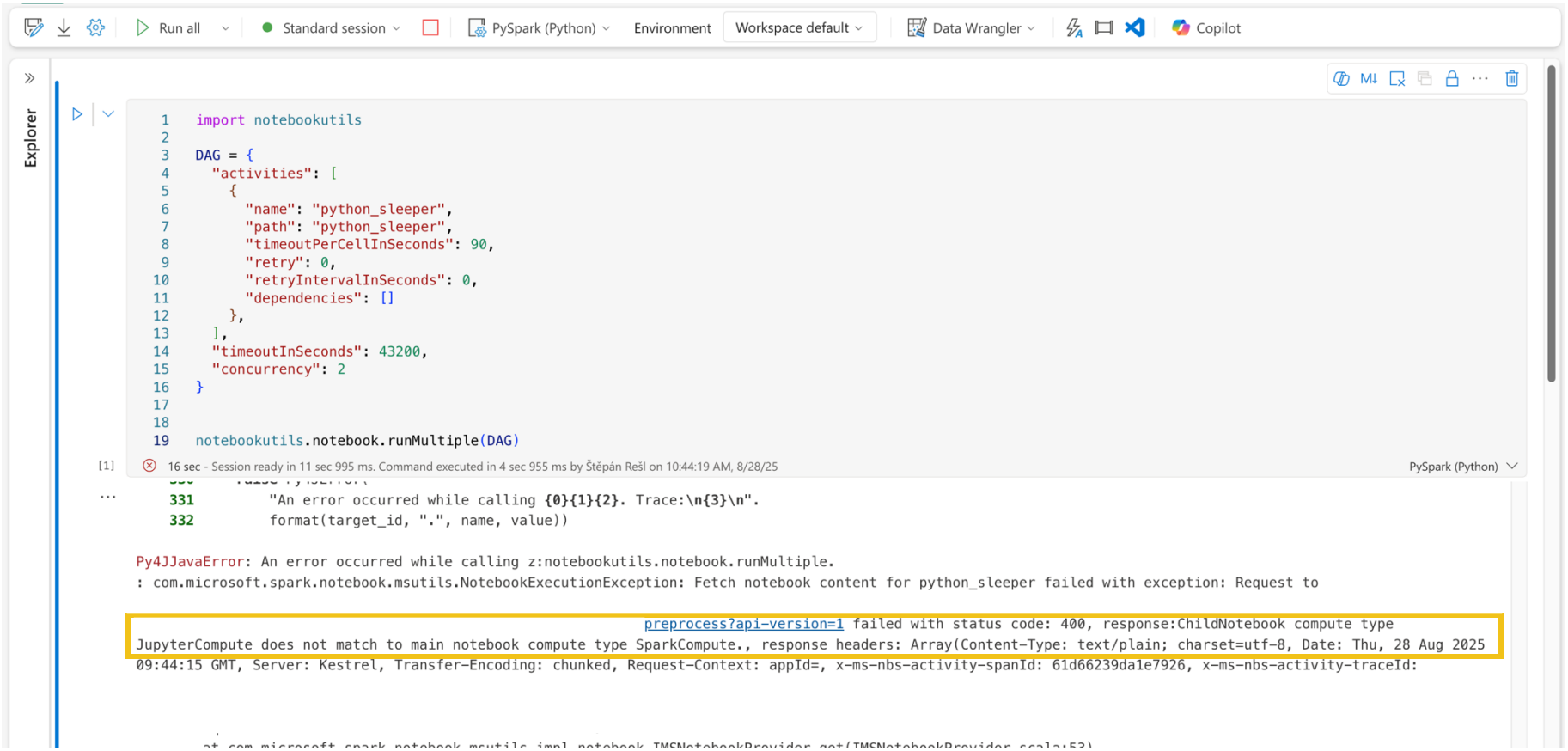
# There is a catch

one more... that you need to have in our mind.

The PySpark notebook can't execute Python notebooks.

Python notebooks can't execute PySpark notebooks.

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# All together

How it can look like...

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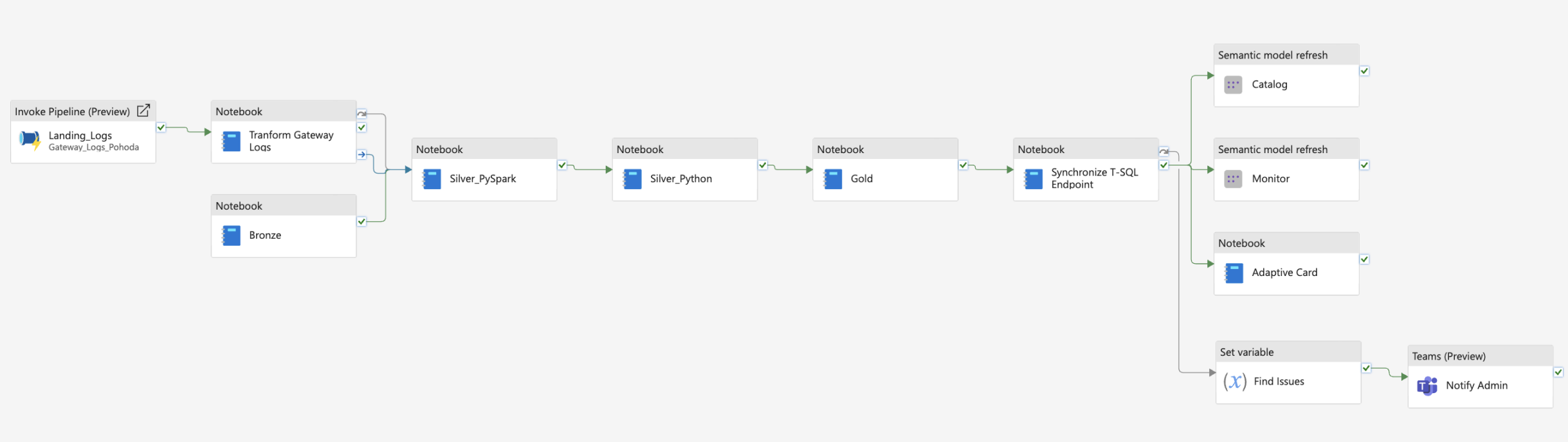
# One pipeline that orchestrates data ingest and transfromations

... including notification to admins and cards with changes in the MS Teams

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# Thats all folks

Thank you for attention.