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Dagster Deep Dive

Cooking with Gas: Building a Data Platform at US Foods

April, 1st 2025

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Speakers

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Disorganization is the Enemy

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Platform Principles

Disorganization is the Enemy

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Platform Principles

Efficiency at Every Level

- Reduce cognitive load
  - Focus on competency area
- Keep things maintainable
- Build in efficiency with modular design
- Establish single source of truth
- Share parallel patterns
- Minimize action, maximize output
- Transparency

"Always be knolling."

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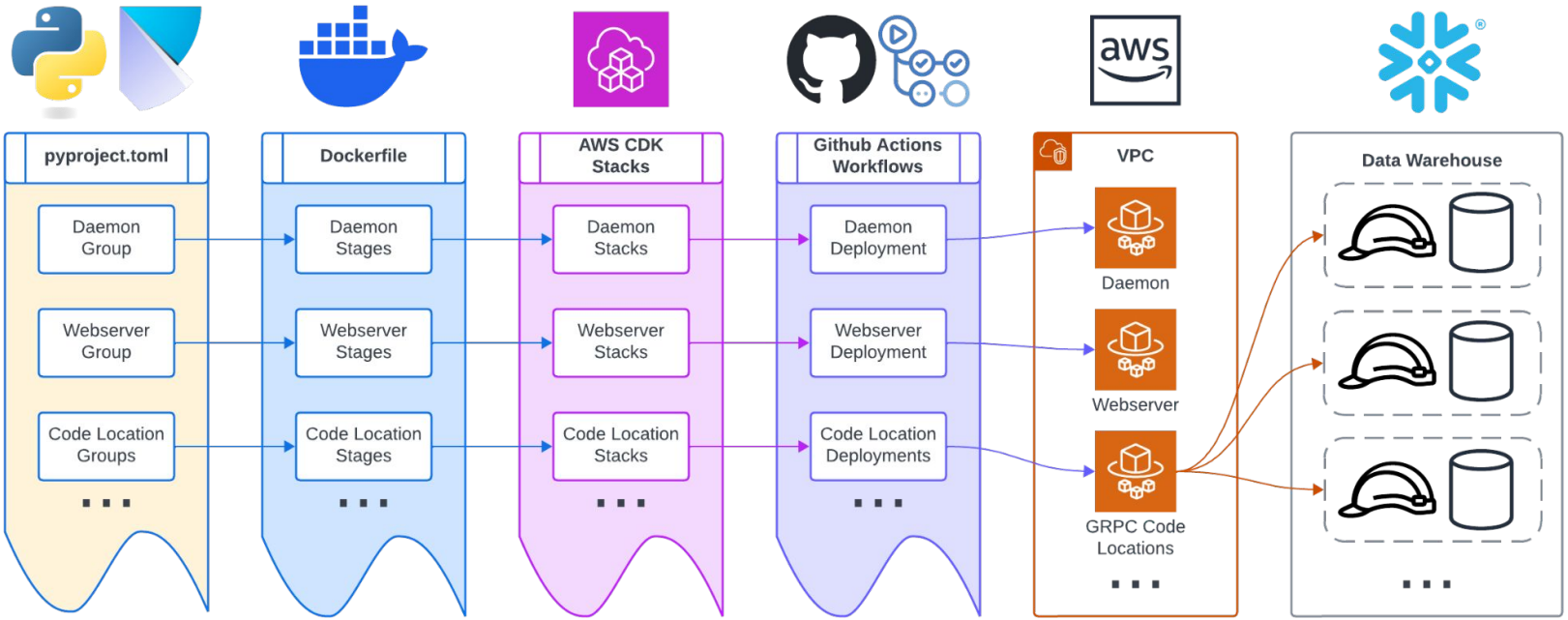
The Big Picture



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Pain Points

Pain Points

Common Issues

Isolated Data Silos

Difficulty aligning cross-functional teams

Resources and Access Friction

Inconsistent access roles and unstandardized methods

Poor Overall Visibility

Redundant work, duplicate code and data

Suboptimal Governance

Loose environmental and database boundaries

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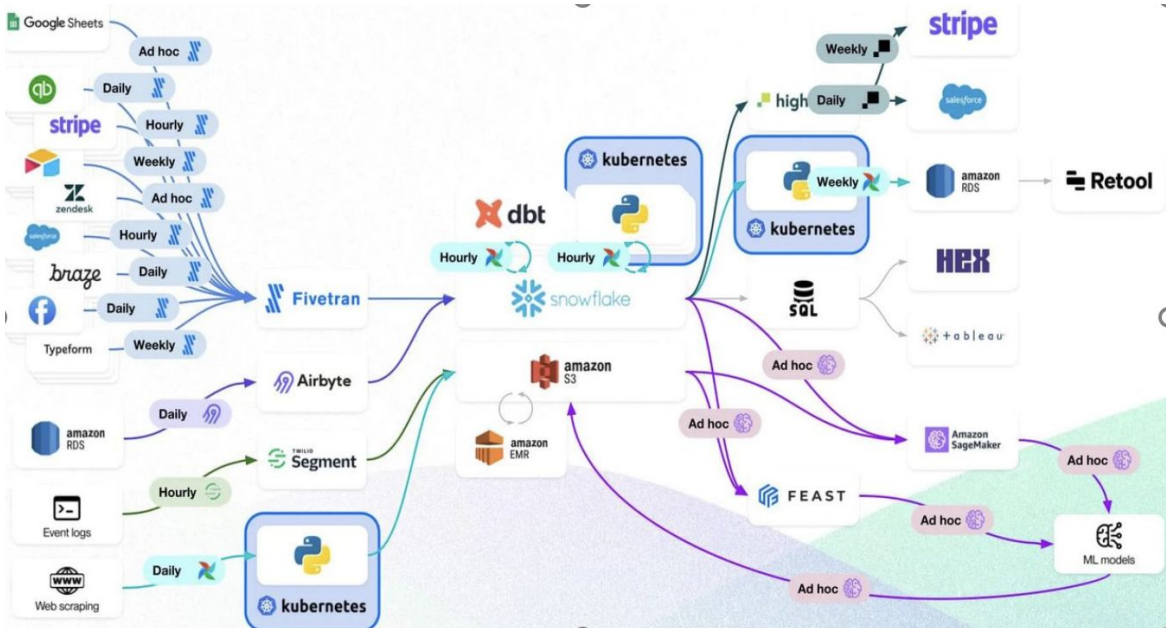
Pain Points

Where We Were

- Fragmented “DAGs” in Alation
- Ad hoc scripting
- Infrastructure soup
- “cust_data_dev_smith”



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Chefs Love the Kit

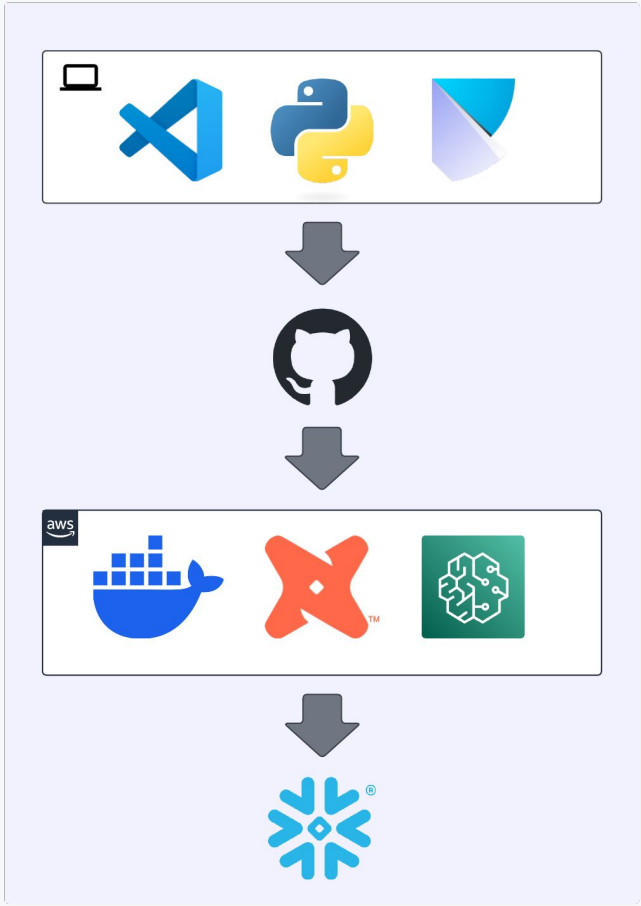
Tool Selection

Tool Selection

Why Dagster?

- Asset-based orchestration
- Rich UI and monitoring
- Extensive integration capabilities
- Strong typing
- Familiar interface and dependency injection
- Anything Python can be done in Dagster
- VISIBILITY
- Local/cloud development parity

Supporting Tools



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We Built This City

Platform Foundation

Poetry & pyproject.toml

The First Source of Truth

- Everything else is downstream of this file
- Dependency groups for modular deployment
- Consistency across environments - local, development, staging, production
- No multiple requirements.txt file sprawl
- Streamlined task execution with Poe

```
[tool.poetry.dependencies]
python = ">=3.11, <3.13"
boto3 = "^1.28.20"
snowflake-connector-python = {extras = ["pandas", "secure-local-
storage"], version = "^3.12.3"}
...

[tool.poetry.group.daemon.dependencies]
dagster-postgres = "^0.25.4"
...

[tool.poetry.group.saute.dependencies]
statsforecast = "^1.7.4"
...

[tool.poetry.group.infra.dependencies]
aws-cdk-lib = "2.162.0"
...

[tool.pytest.ini_options]
...

[tool.ruff]
...

[tool.poe.tasks.dev]
help = "Starts a local dagster instance with the dev deployment
configuration. Requires at least one '-m' flag to specify a module to
load. ex: `poetry dev -m saute`"
cmd = "dagster dev -d ./src"
env = { DAGSTER_HOME = "${PWD}/dagster_home", DEPLOYMENT = "local" }
deps = ["_pwd", "_install_deps"]
uses = { PWD = "_pwd" }
```

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Containerization Strategy

TODO catchy something

- Multi-stage Dockerfile
- Poetry dependency groups one-to-one mapping to container stages
- Build optimization techniques
  - Don’t invalidate the cache!
  - Use layer caching on ECR with Buildx

```
FROM python:3.11-slim AS dagster-base

# poetry setup
RUN curl -sSL https://install.python-poetry.org | python3 -
...

# dagster setup
ENV DAGSTER_HOME=$PYSETUP_PATH
# build context = project root, so the paths here are relative to that
COPY ./infra/workspace.yaml $DAGSTER_HOME/workspace.yaml
COPY ./infra/dagster.yaml $DAGSTER_HOME/dagster.yaml
WORKDIR $DAGSTER_HOME
...

# final daemon and webserver images
FROM dagster-base AS daemon
RUN poetry install --only daemon --no-root --no-cache

FROM dagster-base AS webserver
RUN poetry install --only daemon,webserver --no-root --no-cache
...

# final saute stages
FROM dagster-base AS saute-builder
RUN poetry install --only main,daemon,saute --no-root --no-cache

FROM dagster-base AS saute
COPY --from=saute-builder $VENV_PATH $VENV_PATH
COPY ./src/saute /src/saute/
...
```

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Infrastructure as Code

AWS CDK

- Single upstream infrastructure stack to define shared components
  - infra buckets, load balancers, ECR repos, etc
- Team stacks define ECS Fargate components and other resources unique to each team

```python
IMAGE_TAG = os.getenv("IMAGE_TAG", "latest")  # branch name

# GRPC server image parameters
GRPC_ECR_REPO = "ia-dagster/saute"
GRPC_DIGEST = os.getenv("GRPC_DIGEST")
COMPLETE_IMAGE_TAG = ...

# get env/secrets keys from template.env to set them as CDK parameters
secrets_from_dotenv = dotenv_values("../template.env")
local_only_keys = ...
secrets_keys = [key for key in secrets_from_dotenv if key not in local_only_keys]

class SauteStack(Stack):
    """Stack for the Saute team's Dagster ECS service."""

    def __init__(self, ...):
        secrets_dict = {key: ecs.Secret.from_secrets_manager(secret, key) ...}
        env_dict = {...}
        self.log_group = logs.LogGroup.from_log_group_name(...)
        self.task_role = iam.Role(...)
        self.saute = ecs.FargateTaskDefinition(...)
        self.saute.add_container(
            container_name="saute",
            image=ecs.ContainerImage.from_ecr_repository(
                repository=ecr.Repository.from_repository_name(
                    repository_name=GRPC_ECR_REPO
                ),
                tag=COMPLETE_IMAGE_TAG,
            ),
            command=[
                "dagster",
                "code-server",
                "start",
                "-m",
                "saute",
            ],
            ...
        )
        self.saute_service = ecs.FargateService(...)
        self.saute_bucket = s3.Bucket(...)
        self.saute_reload_lambda_trigger = triggers.TriggerFunction(...)
```

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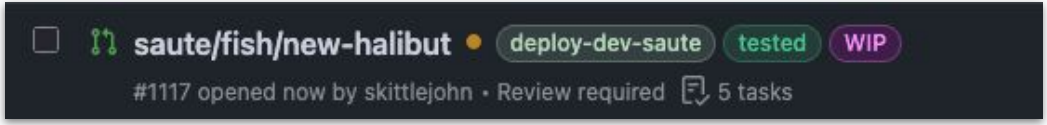
CI/CD

Github Actions

- Team-agnostic label-based workflows
- Use team names to target correct upstream constructs
- Deployment pipeline
  - Builds container for specific team
  - Environment-specific configurations (dev/staging/prod)
  - Deploys corresponding CDK stack




```yaml
- name: Build and push to ECR
  id: build-push
  uses: docker/build-push-action@v5
  with:
    context: .
    file: ./infra/Dockerfile
    target: ${{ inputs.team_name }}
    tags: ${{ steps.ecr-login.outputs.registry }}/ia-dagster/${{ inputs.team_name }}:
${{ inputs.image_tag }}
    cache-from: type=registry,ref=${{ steps.ecr-login.outputs.registry }}/ia-dagster/
${{ inputs.team_name }}:buildcache
    cache-to: type=registry,mode=max,image-manifest=true,oci-mediatypes=true,ref=${{
steps.ecr-login.outputs.registry }}/ia-dagster/${{ inputs.team_name }}:buildcache
    push: true
...

- name: Install infra dependencies
  run: poetry install --only infra --no-root
...

- name: Deploy stack
  id: deploy
  working-directory: ./infra
  run: poetry run cdk deploy ${{ inputs.stack_name }} --require-approval never -c
env=$DEPLOYMENT
```

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How we do it

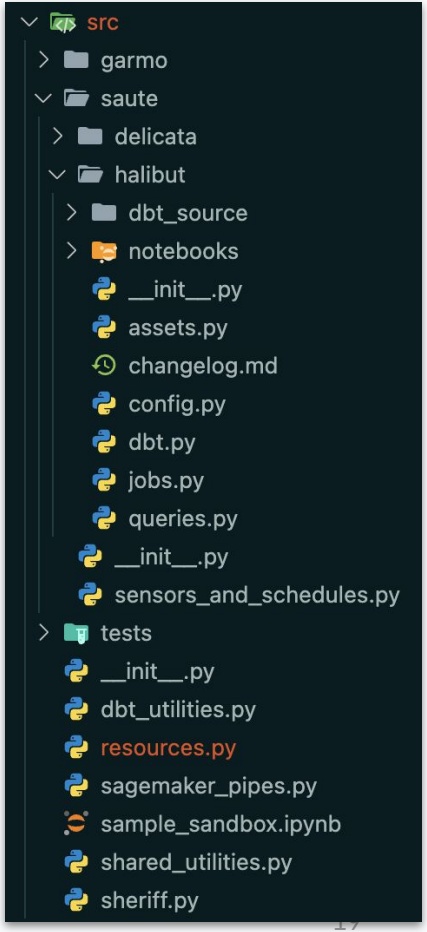
Dagster Implementation

Code Location Directory Strategy

Avoiding the “import circus”

- One-to-one modular mapping
- Team separation by directory
- Team directories copied into team images
- Shared utilities for resources
- Absolute imports only - works regardless of where the code runs - notebook, dev, prod, etc

```
from saute.fish.config import (
    FishConfig,
    metadata,
    project,
    tags,
    team,
    ...
)
from saute.fish.feature_engineering import (
    engineer_features,
    impute_bycatch,
    ...
)
from saute.fish.utils import (
    butter_baste,
    debone,
    ...
)
```



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Dependency Injection

Environment Configuration

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Environment Configuration

Dependency Injection

- Triplicate deployments for each code location - development, staging, and production environments
- Very flexible - some teams need different resources - Kafka, MSteams, etc.
- Standardized configuration patterns set by environmental variables
- Environment-specific resources and configurations per team

```python
if os.getenv("DEPLOYMENT") in ["prod", "staging", "dev"]:
    io_manager = S3PickleIOManager(
        s3_resource=BaseS3Resource(),
        s3_bucket=EnvVar("BACKEND_BUCKET"),
        s3_prefix="io_manager",
    )
    pipes_bucket = f"{os.getenv('DEPLOYMENT')}-dagster-pipes"
    s3_resource = S3Resource()
    location_resource = LocationResource()
else:
    io_manager = FilesystemIOManager()
    pipes_bucket = "dev-dagster-pipes"
    s3_resource = S3Resource(profile_name=EnvVar("AWS_SSO_PROFILE"))
    location_resource = LocationResource(profile_name=EnvVar("AWS_SSO_PROFILE"))

kafka = KafkaResource(
    bootstrap_servers=EnvVar("KAFKA_BOOTSTRAP_SERVER"),
    key=EnvVar("KAFKA_KEY"),
    secret=EnvVar("KAFKA_SECRET"),
)

snowflake_resource = SnowflakeResource(
    account=EnvVar("SNOWFLAKE_ACCOUNT"),
    user=EnvVar("SAUTE_SNOWFLAKE_USER"),
    password=EnvVar("SAUTE_SNOWFLAKE_PASSWORD"),
    warehouse=EnvVar("SAUTE_SNOWFLAKE_WAREHOUSE"),
    database=EnvVar("SAUTE_SNOWFLAKE_DATABASE"),
    role=EnvVar("SAUTE_SNOWFLAKE_ROLE"),
    echo=EnvVar("DEBUG"),
)
```

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Environment Configuration

Reinforce the Paradigm

- Config.py - the power of tags and definition metadata
- Specify default compute, RAM
- Change at-will in launchpad
- Bespoke Dagster resource instantiation

```python
# config.py
team = "saute"
project = "halibut"
tags = {"team": team, "project": project}
metadata = {
  "Project": project,
  "Documentation URL": "fish.halibut.tasty.com",
  "Owners": ["my_email@host.com", ...]
}
```

```python
# jobs.py
summer_halibut = define_asset_job(
    name="summer_halibut",
    tags={"ecs/cpu": "8192", "ecs/memory": "32768", **tags},
    selection=AssetSelection.asset(...),
    ...
)
```

```python
# resources.py
def setup_for_execution(self, context: InitResourceContext):
    """Dynamically sets default schema by group/project name."""
    self._run_id = context.run_id
    team = context.dagster_run.tags["team"].upper()
    project = context.dagster_run.tags["project"].upper()
    self._snowflake_schema = project
    self._query_tag_string = (
        f"team={team} project={project}"
        f"deployment={DEPLOYMENT.upper()} run_id={self._run_id}"
    )
```

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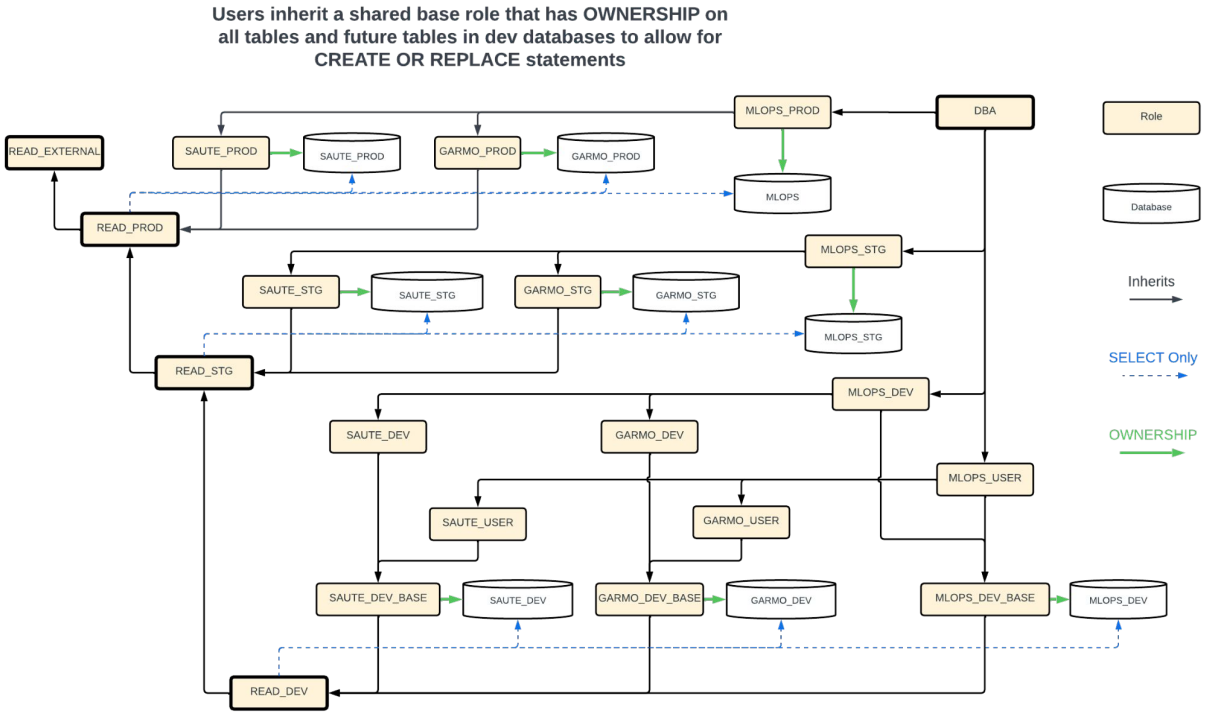
Snowflake

- Database per team per environment - direct mapping from code locations to databases with consistent naming conventions
- Hierarchical RBAC based on team structure with environment-specific permissions
- Zero-Copy Cloning
    - Develop on real data



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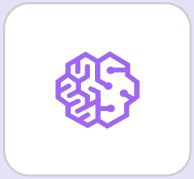
Integrations

aws

dbt



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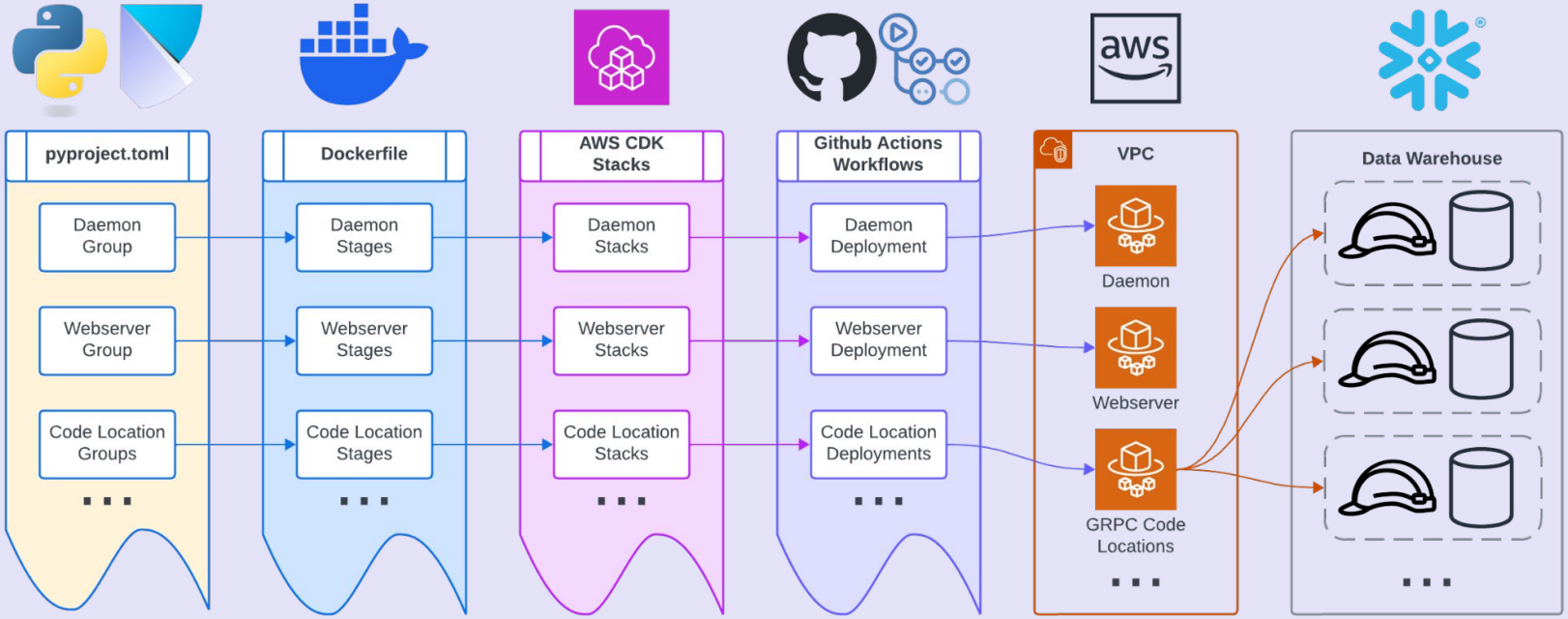
```python
dbt_manifest_path, halibut_dbt_resource = \
    build_dbt_manifest_and_resource(__file__)

dbt_translator = build_project_dbt_translator(
    group_name=project,
    key_prefix=[team, project],
    metadata=metadata
)

@dbt_assets(
    manifest=dbt_manifest_path,
    partitions_def=weekly_partitions,
    backfill_policy=BackfillPolicy.single_run(),
    dagster_dbt_translator=dbt_translator,
)
def dbt_ingestion_assets(
    context,
    config: FishConfig,
    halibut_dbt_resource: DbtCliResource
):

    start, end = context.partition_time_window
    dbt_vars = json.dumps({
        "full_refresh_start_date": config.data_start_date,
        "partition_start": start.date().isoformat(),
        "partition_end": end.date().isoformat()
    })
    dbt_build_args = ["build", "--vars", dbt_vars]

    if config.full_refresh:
        dbt_build_args.append("--full-refresh")

    yield from halibut_dbt_resource.cli(
        dbt_build_args,
        context=context
    ).stream()
```

Putting it All Together



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Putting it All Together

It Just Works

- Simplified troubleshooting and maintenance
- Improved developer velocity
- Standardized configurations

Faster Onboarding

- End-to-end workflow visualization
- Documentation as code in one repo
- Consistent organization across the platform

Empowered Stakeholders

- Self-service for teams.
- Clear ownership and responsibility
- Standardized yet flexible

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Q&A

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Subtitle goes here

Thank you!