globus labs

SUSTech Southern University of Science and Technology

Distributed Dataflows with Parsl + funcX: a FaaS based Approach

Zhuozhao Li

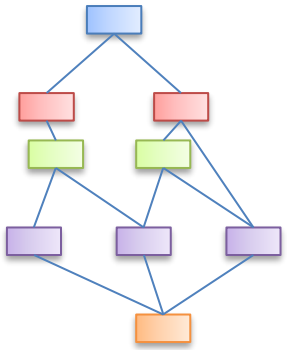
Assistant Professor

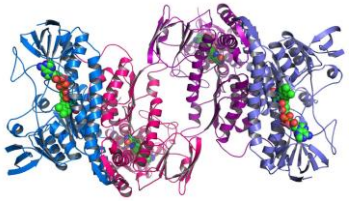
Southern University of Science and Technology

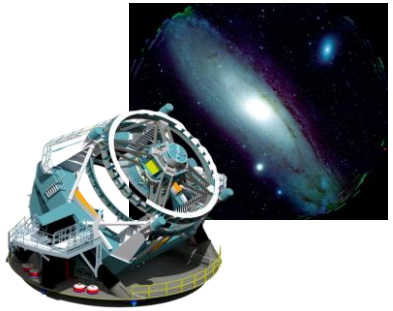
parsl

The needs for distributed dataflows

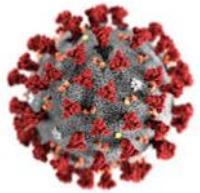
Dependency-based tasks



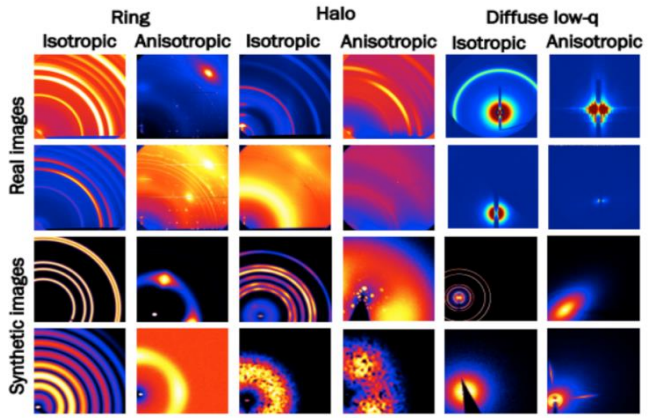




Phenomenal growth of data volumes and velocities



Distributed data and compute



Coffea

Parsl: Enabling composition and dynamic dataflow graph

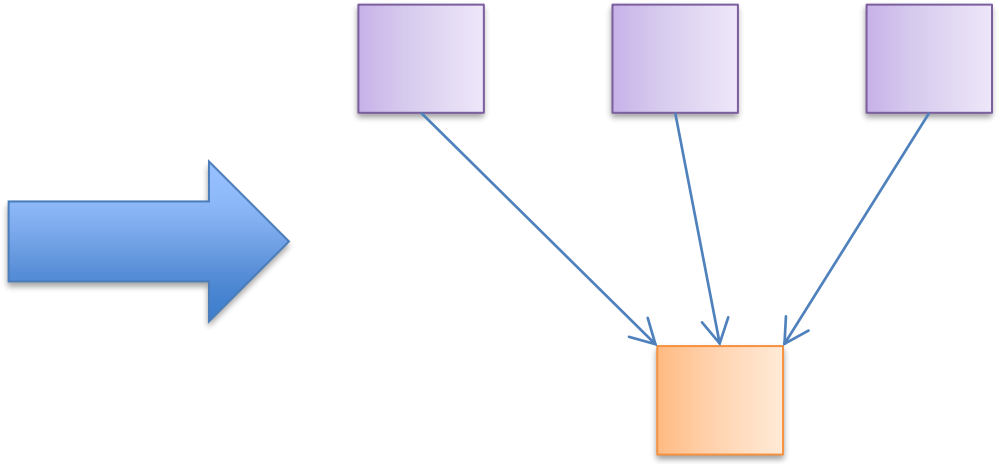
```python
@python_app
def pi(num_points):
    from random import random
    inside = 0
    for i in range(num_points):
        x, y = random(), random()  # Drop a random point in the box.
        if x**2 + y**2 < 1:        # Count points within the circle.
            inside += 1
    return (inside*4 / num_points)

# App that computes the mean of three values
@python_app
def mean(a, b, c):
    return (a + b + c) / 3

# Estimate three values for pi
a, b, c = pi(10**6), pi(10**6), pi(10**6)

# Compute the mean of the three estimates
mean_pi = mean(a, b, c)

# Print the results
print("Average: {:.5f}".format(mean_pi.result()))
```

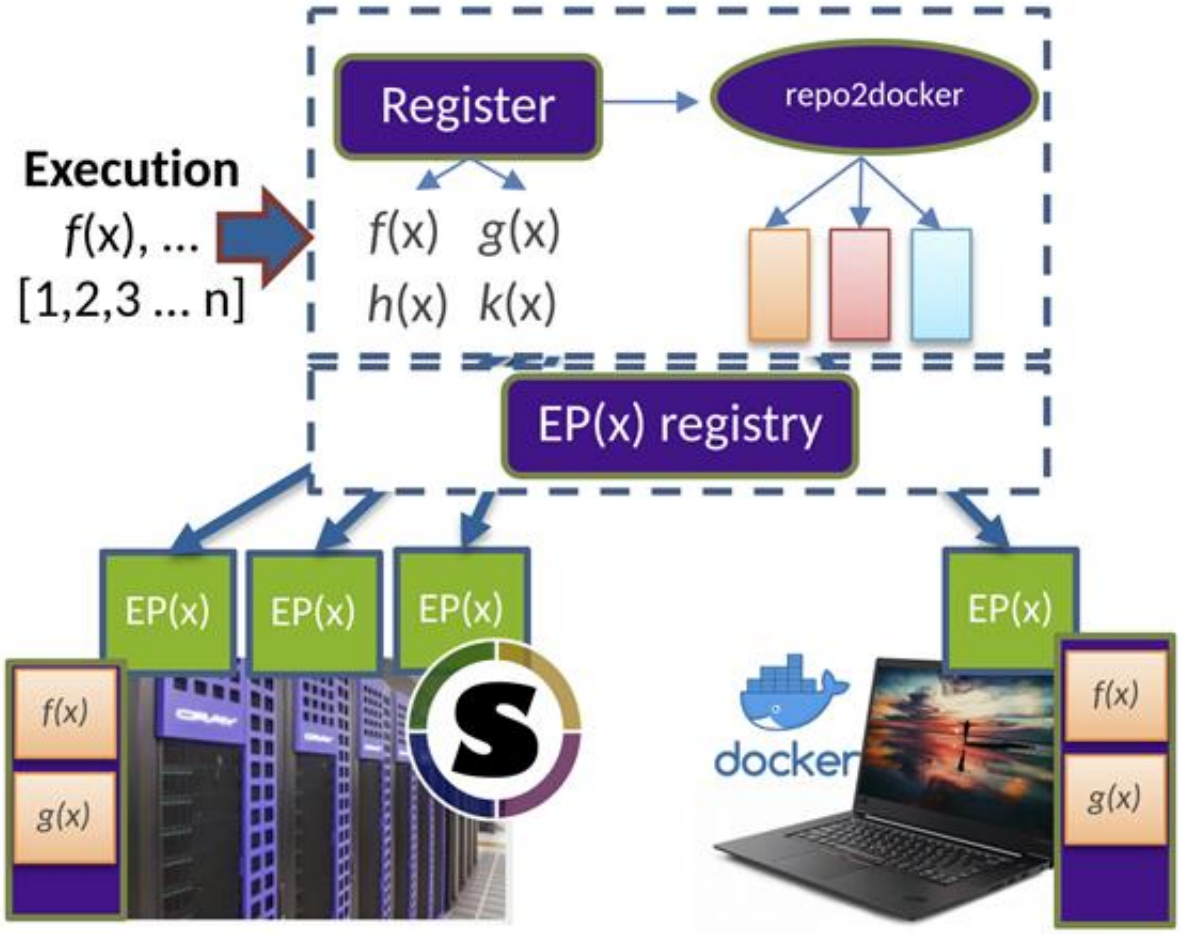


FuncX: A federated FaaS ecosystem

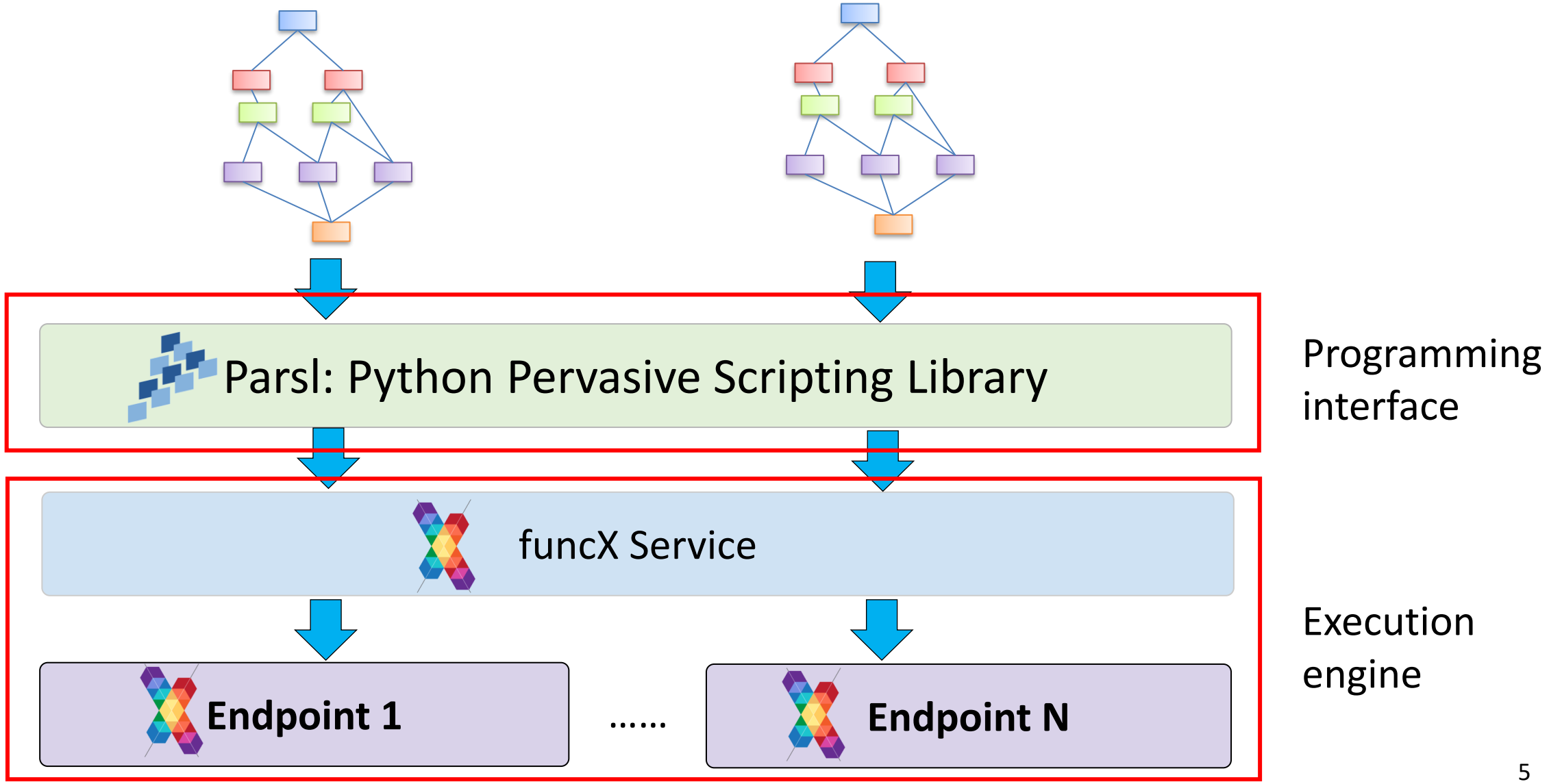
Distributed endpoint model

- Lightweight agent deployed by users
- Dynamically provisions resources, deploys containers, and executes functions

Turn *<u>any</u>* machine into a function serving endpoint



A new funcX executor for Parsl (prototype)

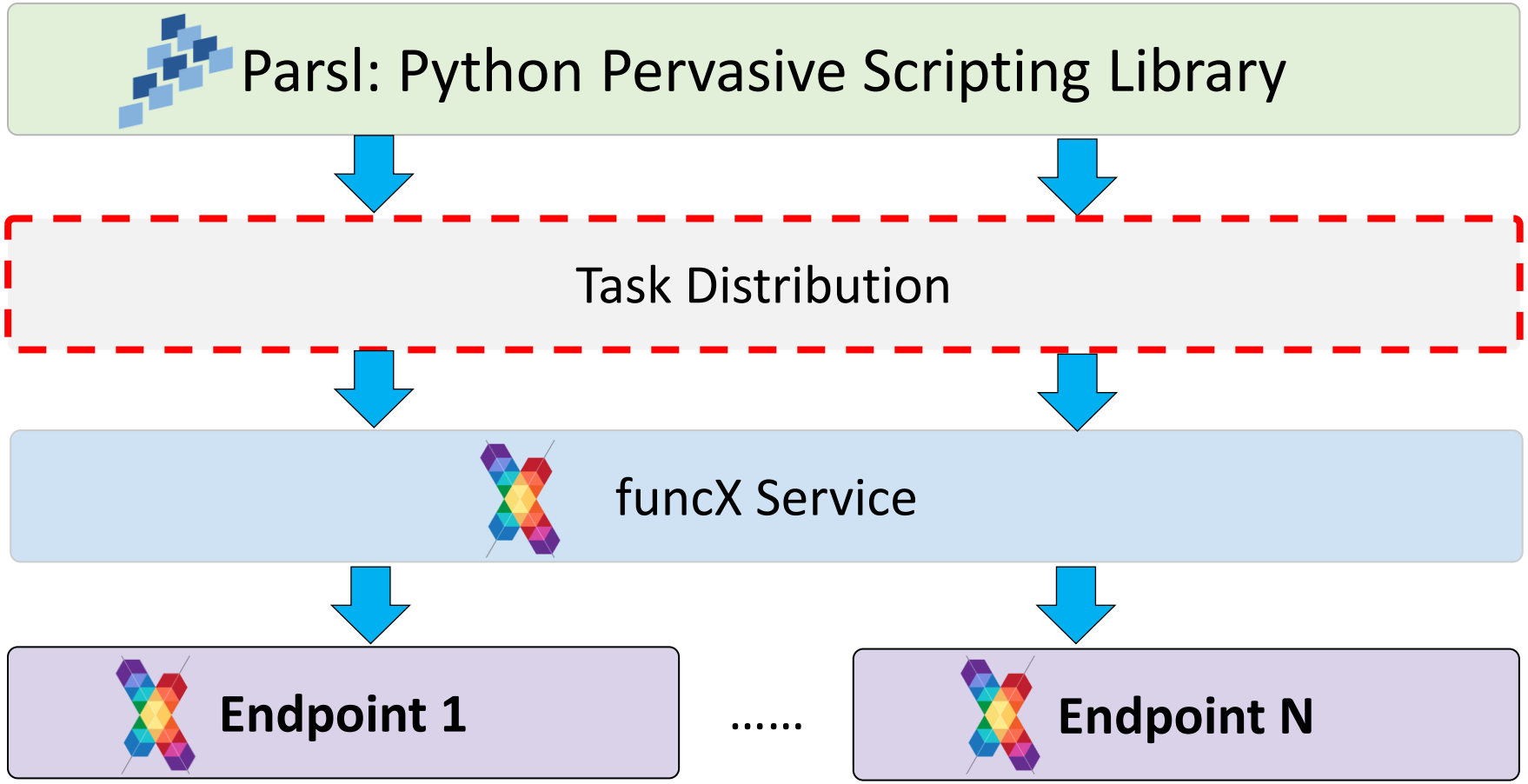


A new funcX executor for Parsl (prototype)

```
from parsl.executors import FuncXExecutor

fx_config = Config(
    executors=[
        FuncXExecutor(
            label="funcX",
            # worker_debug=True,
            endpoints=['870b1d5d-28b0-4962-877f-886d96d4d785'],
        )
    ],
)
parsl.load(fx_config)
```

Task distribution across endpoints



Task distribution across endpoints

- Allow distributing tasks to specific endpoints manually
  - Decorators

```
@python_app(..., parsl_resource_specification={'endpoints': [ep1, ep2]})
def foo():
```

  - On task invocations

```
foo(*args, **kwargs, parsl_resource_specification={'endpoints': [ep1, ep2]})
```

- Advanced topics
  - Automatically and transparently distribute tasks to their most appropriate endpoints
  - E.g., where data is located, resources are available, or compute is the most efficient
  - Extensible to customized task distributing algorithms

Task and endpoint status reports are needed!

- Endpoint status
  - Liveness
  - Available workers
  - Walltime
  - Queue length
  - etc.

```
def get_endpoint_status(self, endpoint_uuid):
    """Get the status reports for an endpoint.
    Returns
    -------
    dict
        The details of the endpoint's stats
    """
```

- Task status
  - Task utilization
  - Task completion time
  - Data size

It is extremely challenging to report and store task status across distributed endpoints and at scale!

Data management

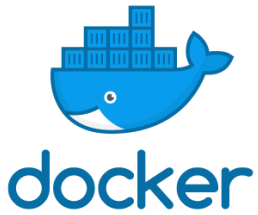
- Inter-endpoint transfers
  - E.g., Globus

- Intra-endpoint transfers
  - E.g., Shared file system
  - In-memory store, e.g., Redis clusters
  - Other approaches, e.g., RDMA

- Data proxy --- transparent, uniform interface

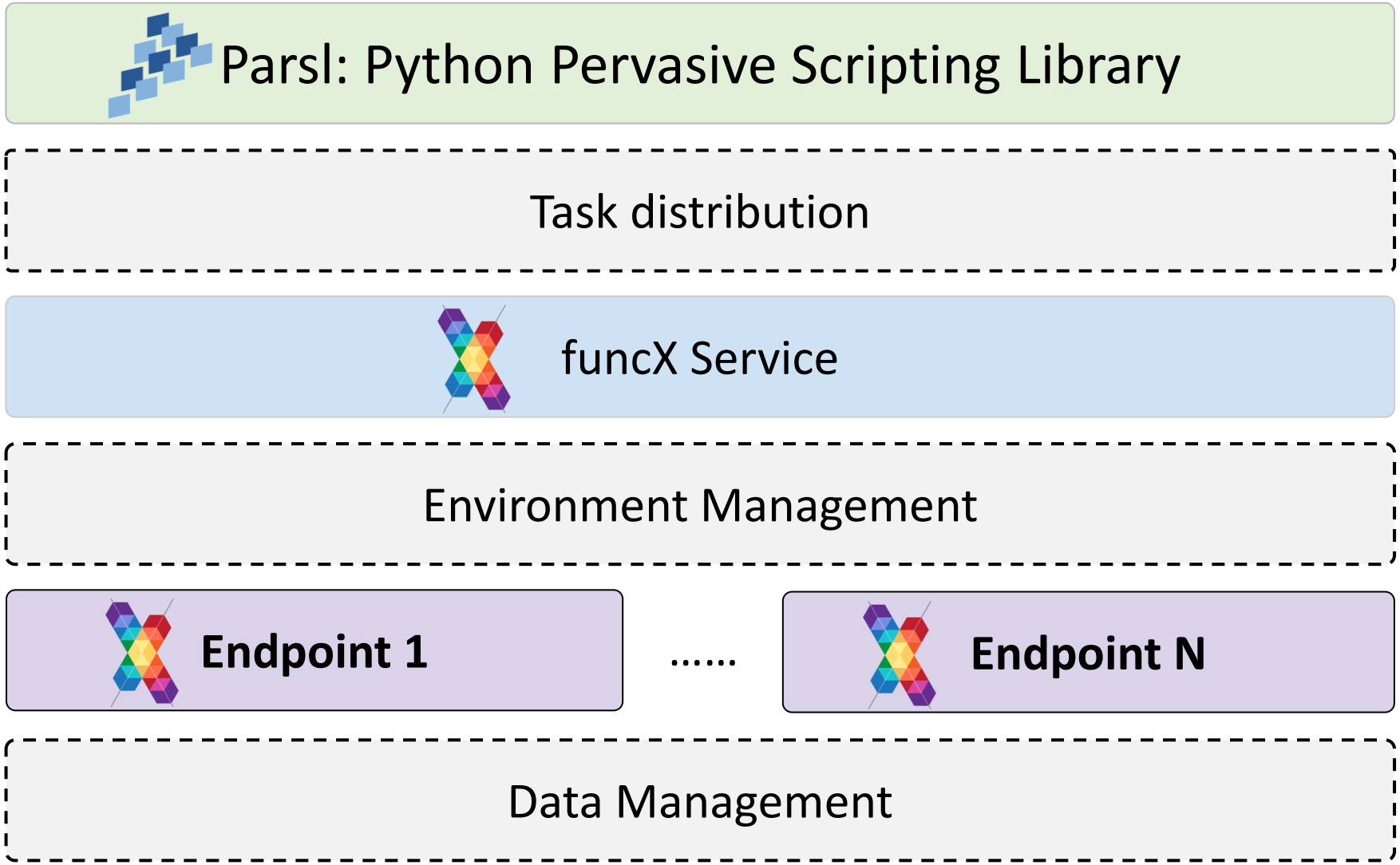
Managing environments across endpoints

- Lightweight function monitor (IPDPS'21, collaborative work with Douglas Thain's lab at ND)
  - Automatically detect the dependencies of functions
  - Package conda environments
  - Distribute environments to workers



- Alternatives: E.g., container service for funcX
  - Dynamically build containers for funcX functions for different endpoints (e.g., Docker, singularity)

Distributed Dataflows with Parsl + funcX



Benefits

- Enable one to easily compose a distributed dataflow across different endpoints, without worrying too much about the task distribution
- Compute on cluster resources from one's laptop
- Portable dataflows
- The potential to use distributed computing resources to avoid high queuing time of large jobs
- More…

Thanks!

Questions!

Suggestions!

Potential use cases!