# Named Data Networking Strategies for Improving Large Scientific Data Transfers

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# Motivation

- Scientific communities are unable to support all computations at generation site
  - Must transfer data over the network

- Infrastructure is insufficient to accommodate all concurrent requests
  - Time shared
  - Must complete within a deadline to make room for others

# How Large?

PhEDEx – CMS Data Transfers

Info | Activity | Data | Requests | Components | **Reports** | Next-gen website

Daily Reports | Daily Report | **File Sizes** | Site Usage | Group Usage

**File size statistics 0h14 ago**

| Files | Total Size | Min Size | Max Size | Mean Size | Median Size |
|---|---|---|---|---|---|
| 95072007 | 269.10 PB | 0.00 MB | 163.82 GB | 2.83 GB | 2.78 GB |

**File size breakdown**

| Bin | | Files | Total Size |
|---|---|---|---|
| 0.00 GB .. | 0.01 GB | 11740167 | 43.40 TB |
| 0.01 GB .. | 0.02 GB | 1716164 | 22.98 TB |

# Outline

- Background on scientific data transfers
- Problems
- Building blocks
  - NDN-based bandwidth reservation
  - On-demand path creation
  - NDN strategies
- How to use these blocks for a deadline based data transfer protocol
- Analytical evaluation
- Conclusions

# Problems

- No support from the network
  - Hard to implement applications
  - Hard to optimize deadline-based data transfers
  - Network resources are not optimally used

- Intelligent applications does not solve inherent problems
  - Support from the network would be helpful

# TCP/IP’s shortcomings

- End-to-end paths
  - No reusability of content
- No intelligence in the network
  - No multipath forwarding
  - No caching
- Congestion control can be aggressive

# Two types of data transfers

- Bulk data transfers **←-- focus of this work**
  - Terabyte per day for some workflows
  - Can be scheduled early
  - Sensitive to loss

- Interactive traffic
  - VoIP, visualizations
  - Sensitive to delay and jitter
  - Personalized and dynamic

# Deadline-based Transfers

- Scientific communities uses batch transfers
- Clients submit requests and deadlines to a system
  - Application reserves network resources
  - Complex and hard to implement
  - Hard to optimize transfers

# NDN can do better

- NDN can do better
  - Reuse reserved resources for serving requests that falls within a deadline
  - Trade in-network storage for bandwidth
  - Aggregated requests use less resources

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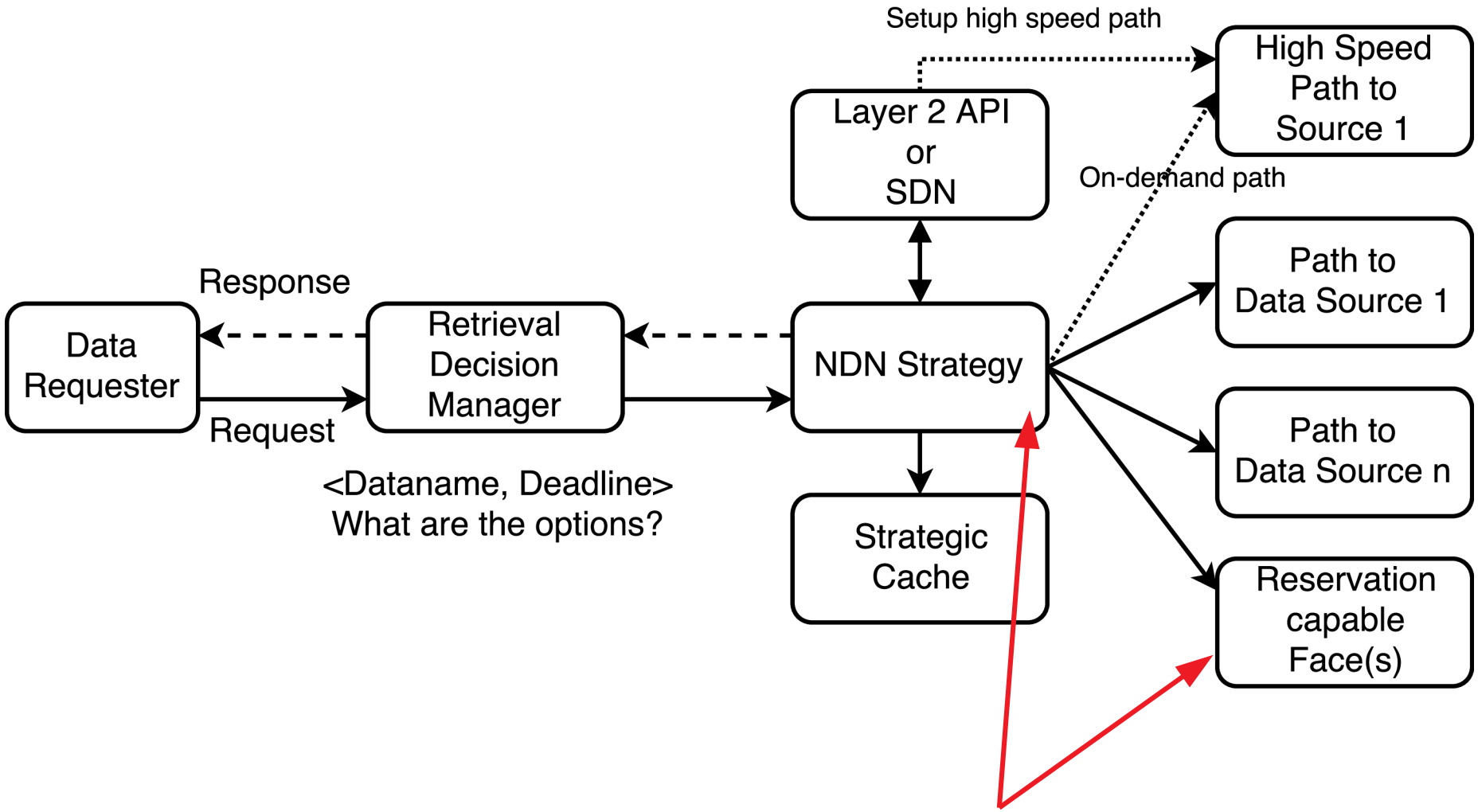
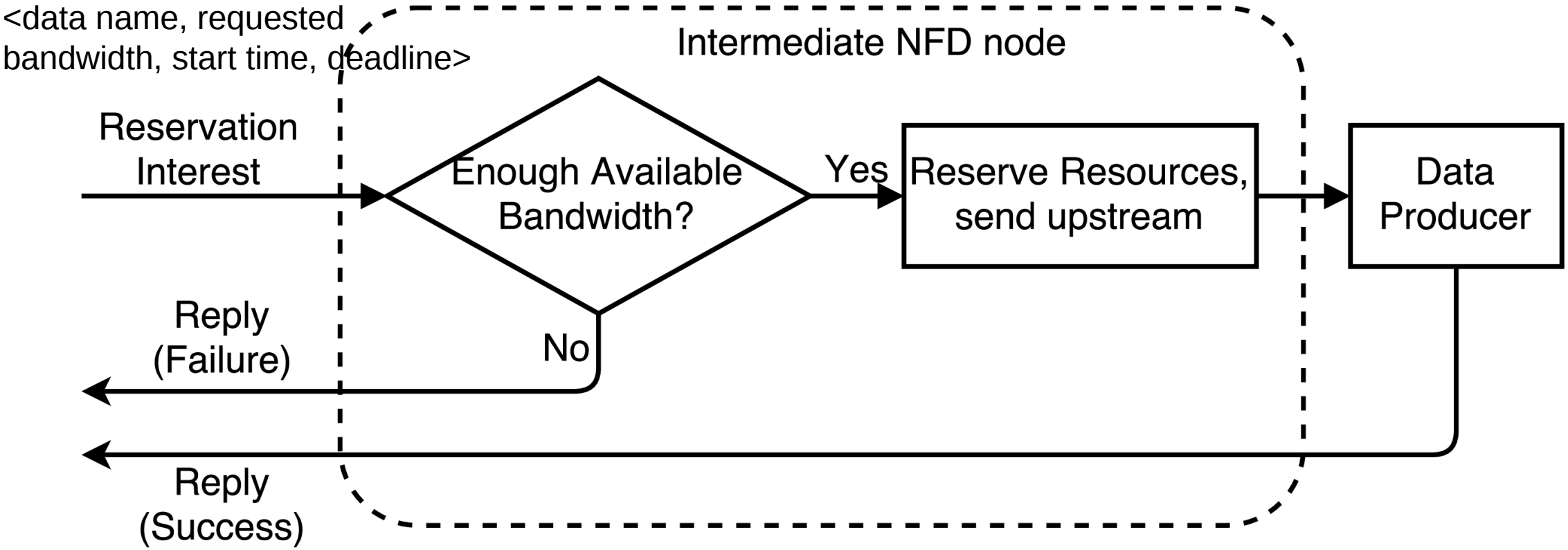
# Overview


Setup high speed path
High Speed Path to Source 1
Layer 2 API or SDN
On-demand path
Response
Data Requester
Retrieval Decision Manager
NDN Strategy
Path to Data Source 1
Path to Data Source n
Request
<Dataname, Deadline>
What are the options?
Strategic Cache
Reservation capable Face(s)

# Resource Reservation in NDN



# Reservation Table

| ReqID | Prefix | Requested StartTime | Deadline | BW |
|---|---|---|---|---|
| 1 | /xrootd | 1463330393 | 1463355592 | 1Gbps |
| 2 | /xrootd | 1463330519 | 1463355623 | 1Gbps |

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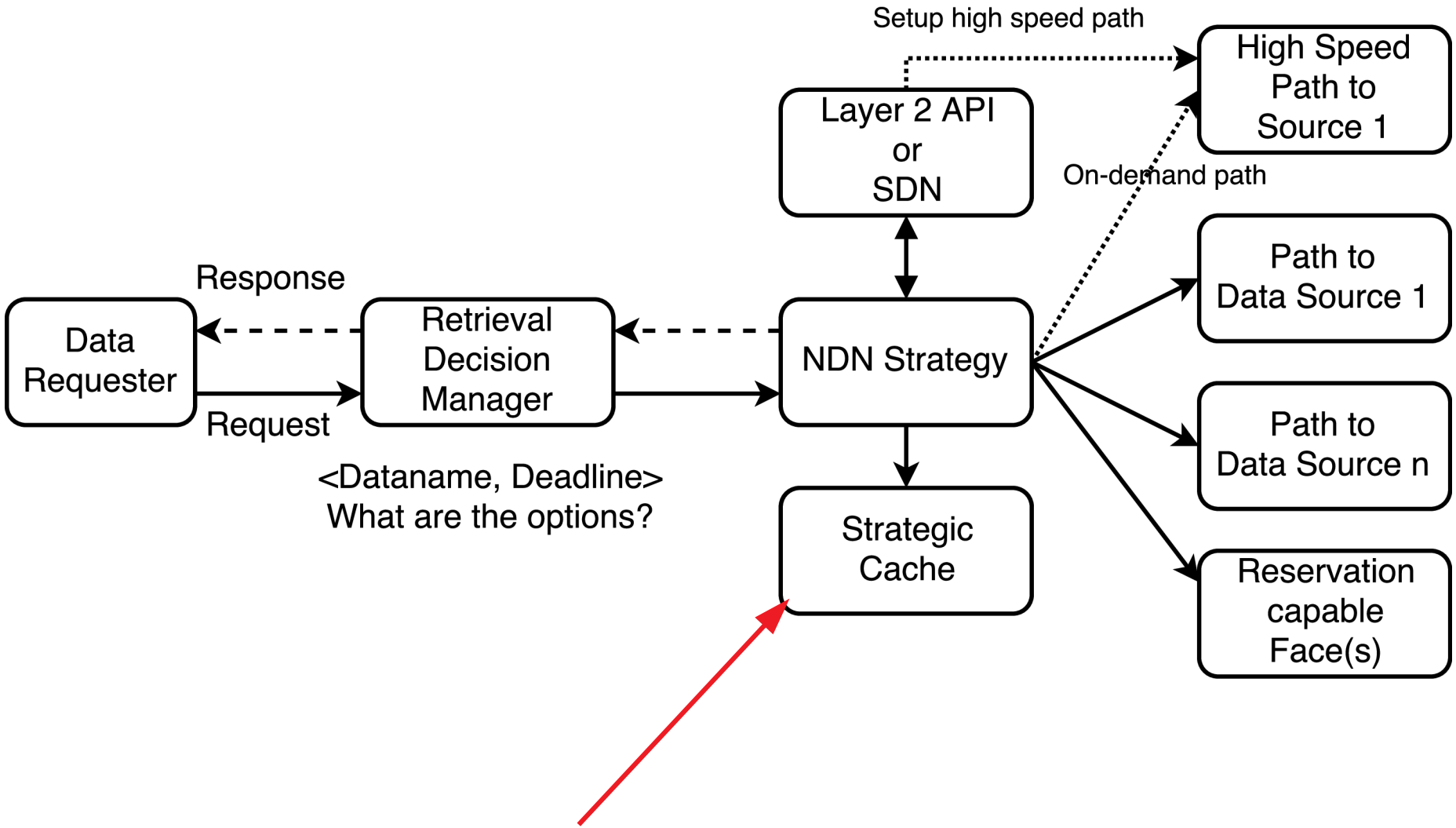
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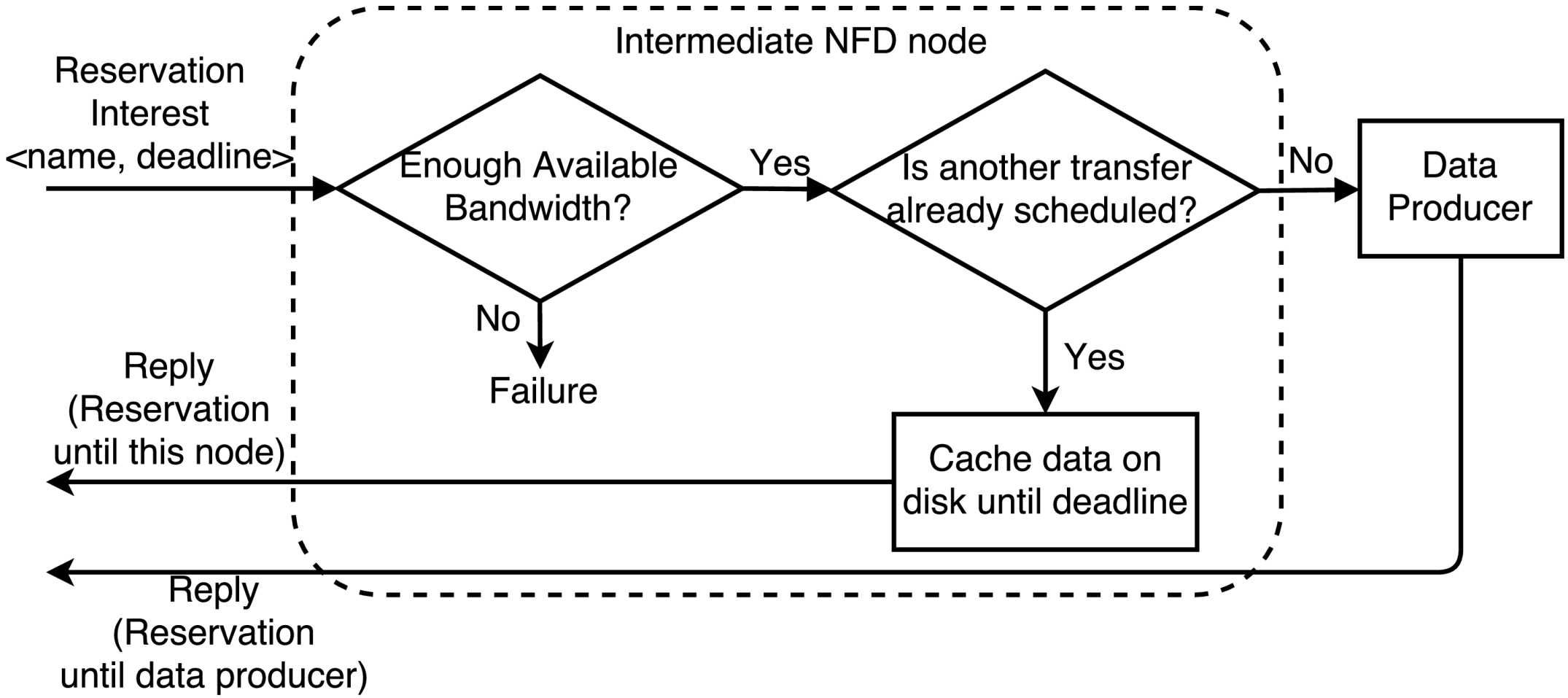
# Strategic Caching



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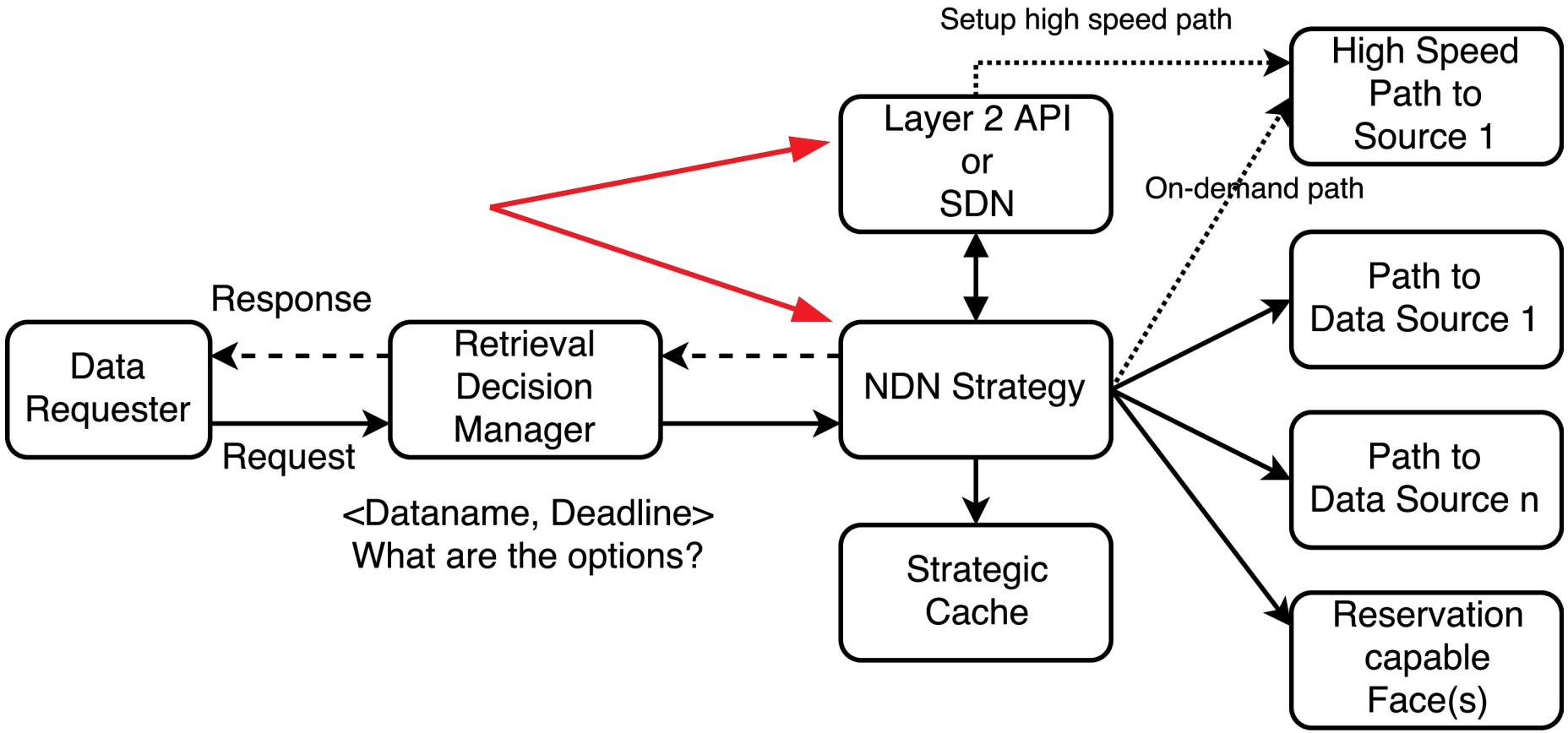
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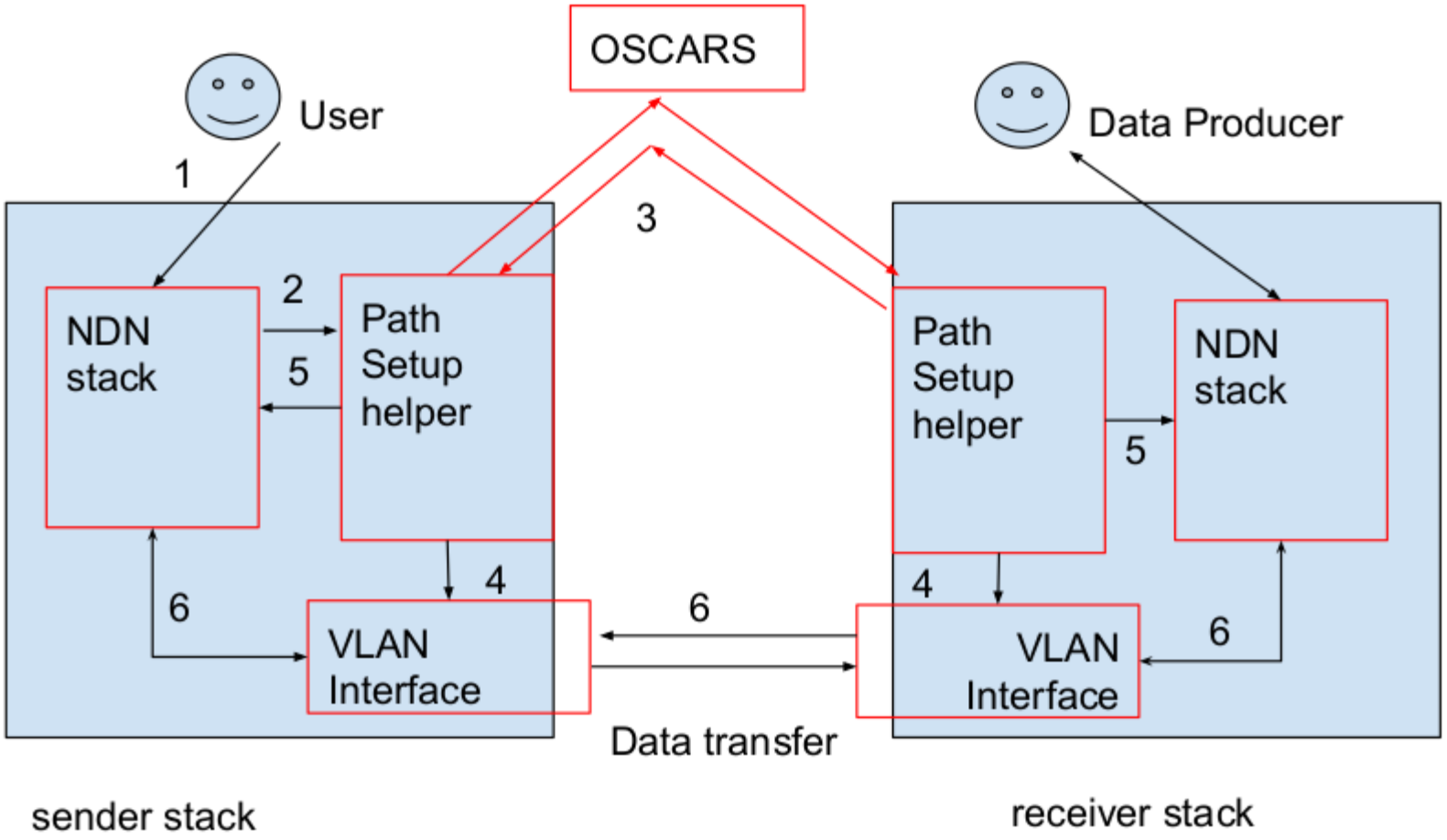
# Create New Paths (OSCARS/SDN)



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# Soft vs Hard Deadlines

- Soft deadline = Best effort
- Hard deadlines = reserved resources

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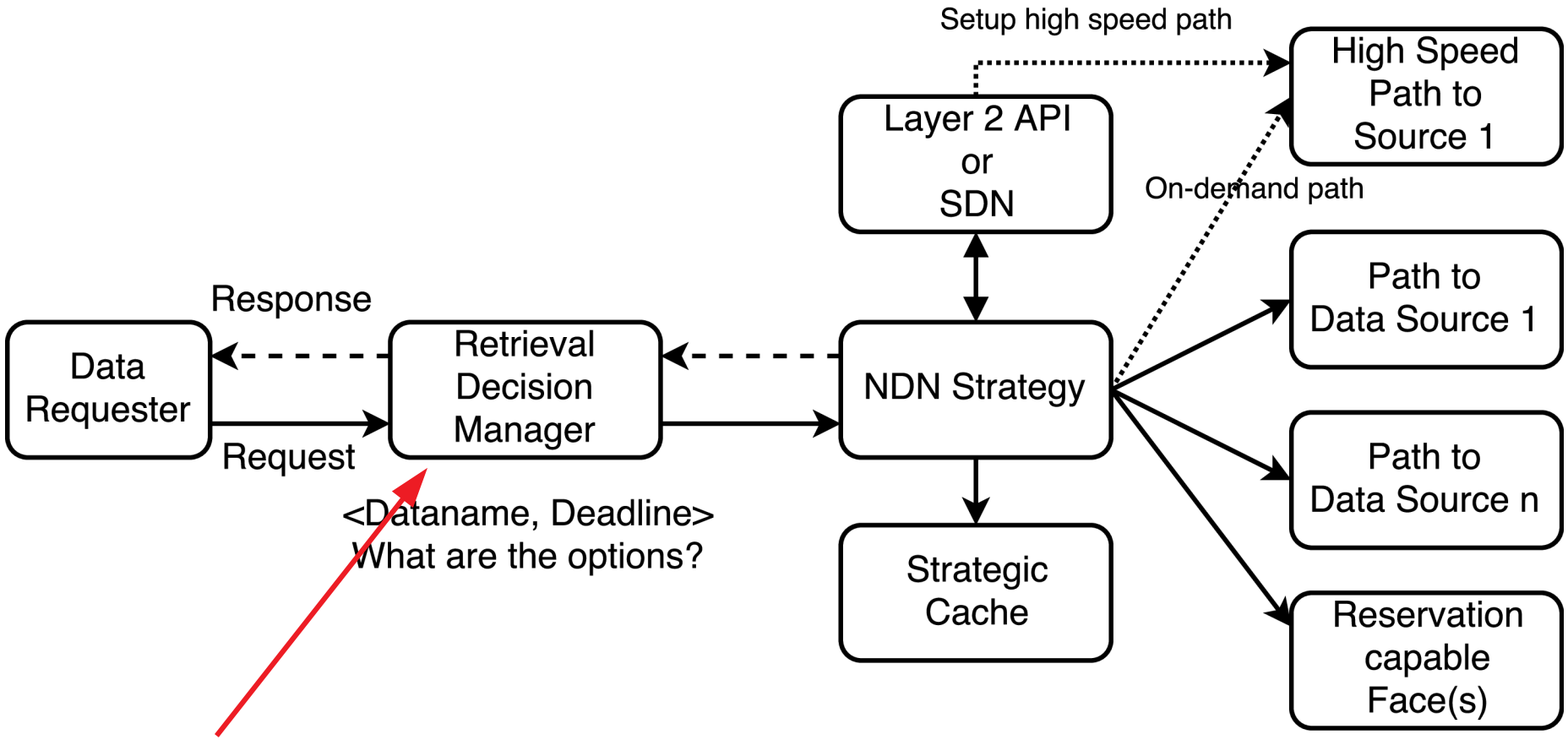
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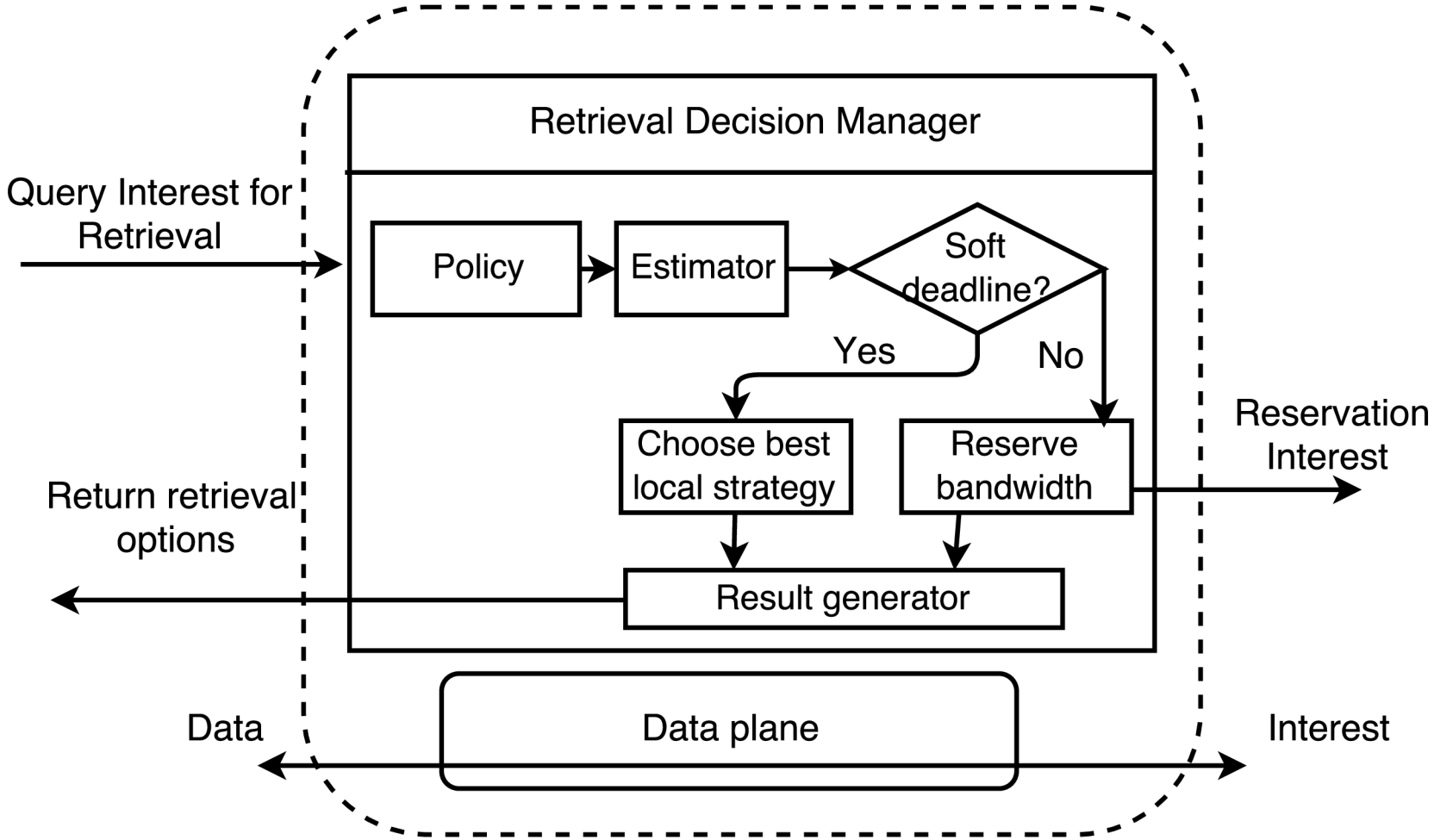
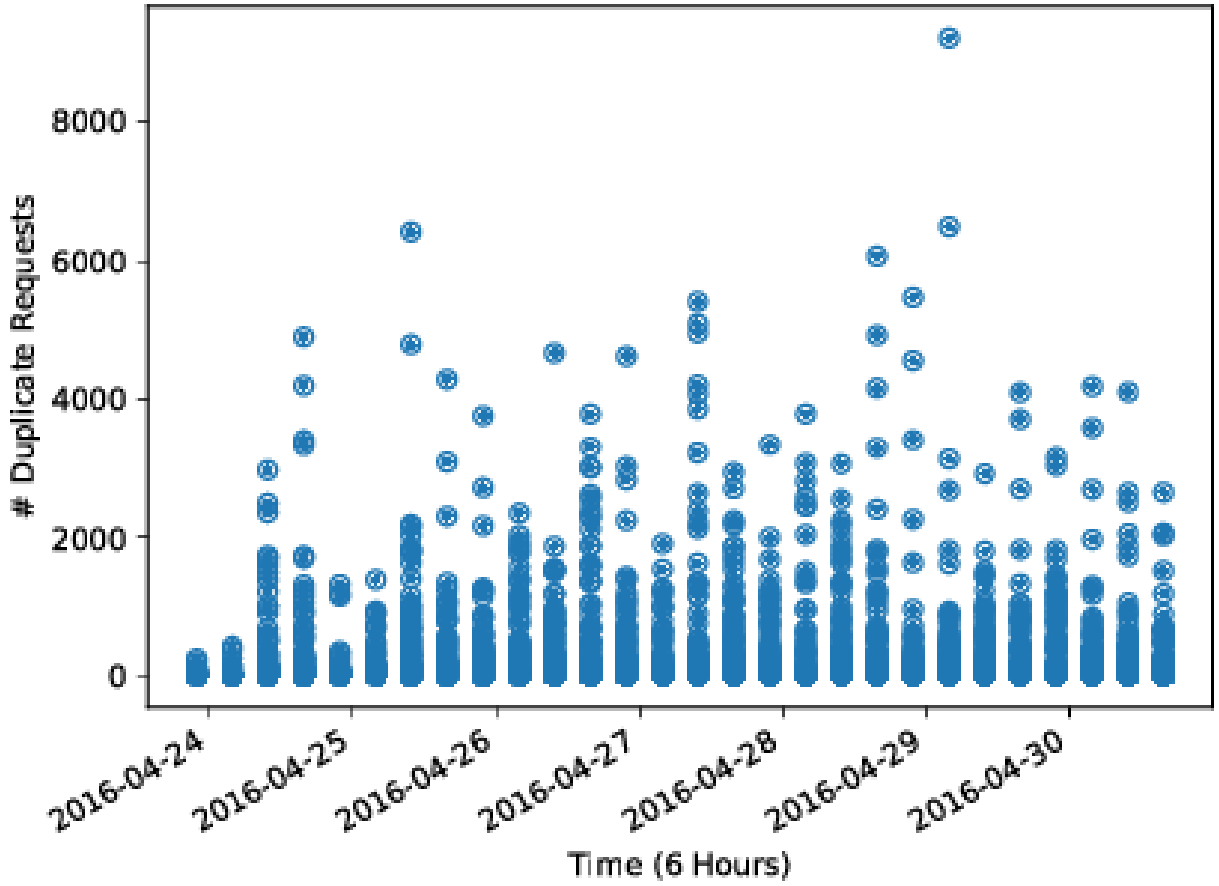
# Retrieval Manager



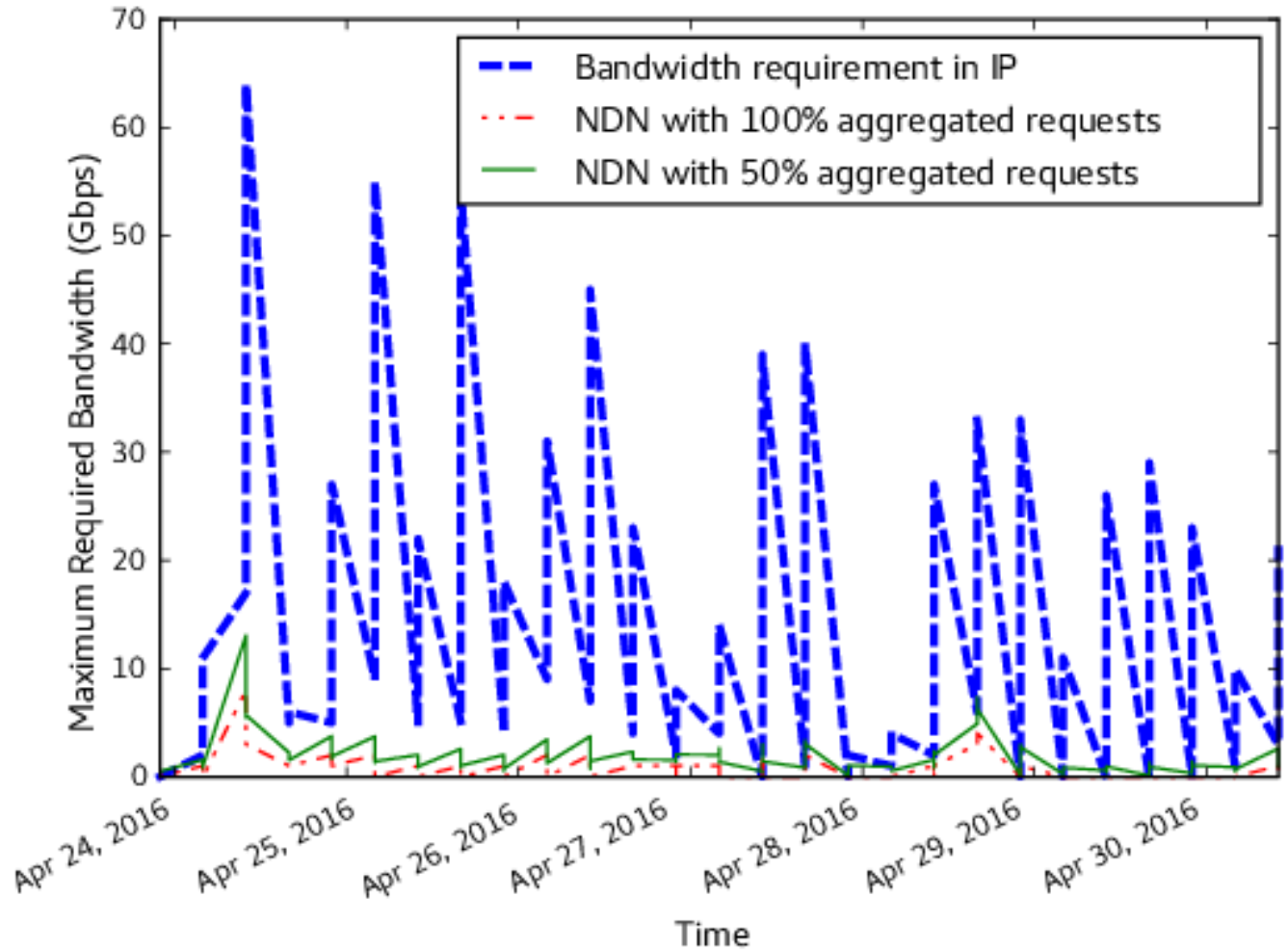
# Analytical Evaluation

- Easier to aggregating requests, cache, and intelligently schedule requests
- Investigate how much resources NDN can save
- More resources saved = more data transfers with same amount of resources

# Duplicate requests



# Bandwidth consumption



# Conclusions

- We propose
  - A hop-by-hop resource reservation mechanism
  - A mechanism to interact with other layers
  - A deadline based data transfer protocol

- We use this protocol an example to demonstrate
  - NDN based network layer can be more flexible and versatile
  - NDN can save resources and accommodate more requests

Questions?

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