Batchy: Batch-scheduling Data Flow Graphs with Service-level Objectives

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Get Things Done in Batches

Icons made by surang, Eucalyp, and srip from flaticon.com.
Batch Scheduling 101
Batch Fragmentation

A

B

C
Batch Defragmentation
Batch Defragmentation

Buffer

A

Buffer

B

Buffer

C

Delay

delay-SLO

Buffer Size
Batchy

Controls queue backlogs to balance **efficiency** and **delays**:

- Process as large batches as possible
- Comply with SLOs by provisioning enough resource
Profile node processing times

![Graphs showing execution time vs batch size for LPM and ExactMatch.]
Batchiness:

\(T\) \(N\) packets in a single batch

\(T\) \(T\) \(N\)-times single-packet batches

← better
System Model

Fractional Buffer

Node
Controller

- Set buffer sizes to comply with SLOs
- Short-circuit useless buffers
- Recover from infeasibility
Architecture

1. Measure $x_0, b_0, \ldots$
2. Adjust $q_v, \forall v \in V$
Controllers

Batchy:

- **Full**: buffer size in interval $[0, \text{max batch size}]$
- **On/Off**: buffer size is either 0 or max batch size

Baseline:

- **Null**: no buffering
- **Max**: all buffers are set to max batch size

**NFVnice**: implemented over BESS
Basic IP Router (L2L3)

- Static traffic-mix
- Delay-SLO: 80% of Max
- 100 ms control period
- Steady-state perf.

16 next-hops
Static L2L3 results

➔ Batch defragmentation improves throughput

Batchy:

➔ successfully reconstructs batches
➔ complies with delay-SLOs
➔ provides the highest throughput
  (thanks to short-circuiting unused queues)
Mobile Gateway

16 users, 2 services

- Service0 (B0):
  - 1ms delay req.
  - Throughput [kpps]:
    10 | 20 | 5 | 50 | 15 | 1

- Service1:
  - Bulk traffic
System Dynamics

Batchy:

➔ keeps delay < 1ms (except transients)

➔ reacts instantaneously

➔ improves the performance of the whole pipeline
Conclusion

- **Batchy** can achieve efficient batch processing in arbitrary graphs without sacrificing latency.

- Code and artifacts are available at [https://github.com/hsnlab/batchy](https://github.com/hsnlab/batchy)