AggNet: Cost-Aware Aggregation Networks for Geo-distributed Streaming Analytics

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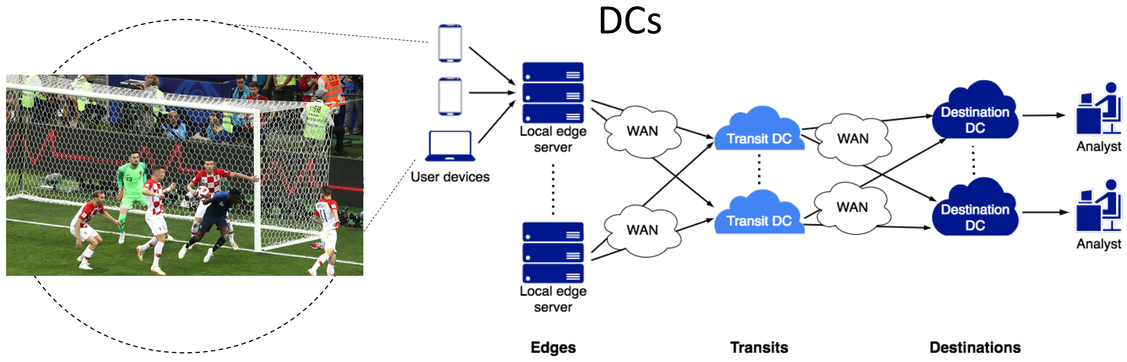
1. Introduction and Problem Statement

Geo-distributed Streaming Analytics

- Video streams, IoT sensors
- QoS monitoring
- Delay-sensitive

Aggregation Networks

- Data sent to DC for analysis
- Partial aggregation on the way
- Edges, Transits, Destination DCs



Challenges:

1. ***Delay*** vs ***Traffic***
- Pure Streaming: *High Traffic, Low Delay*
- Pure Batching: *Low Traffic, High Delay*

2. ***Traffic*** *vs* ***Traffic Cost***
- WAN link costs heterogeneous
- Brazil 8x more expensive than US West

Goal: Minimize **traffic cost** under user-specified **delay bound**

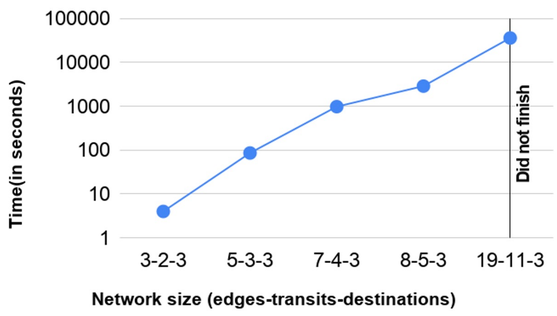
2. Problem Formulation and Solution

Two key problems

1. ***Path provisioning:*** Path from *edge -> transit -> destination*
2. ***Delay budgeting:*** Split delay budget across edges and transits

Joint optimization

- Formulate as a mixed-integer non-linear program
- Returns *optimal solution*
- Too *slow* in practice
- Insights valuable to design heuristic



Insights

1. Minimizing traffic ≠ minimizing traffic cost
2. Route traffic to common transits
3. Aggregating entirely at edge not optimal

iCAPP: Iterative Cost-Aware Path Provisioning

- Breaks down joint optimi - zation into two steps
- Iterates over delay budget split and solves path provisioning
- Hill climbing to find delay budget split

3. Implementation and Setup

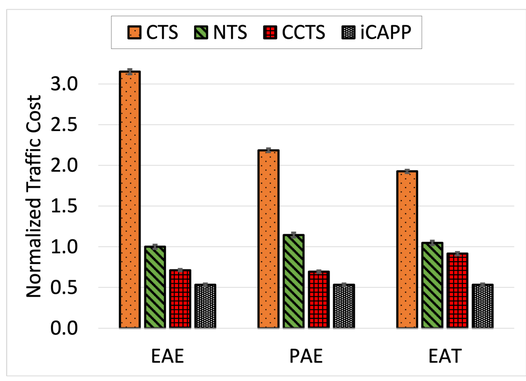
Implementation

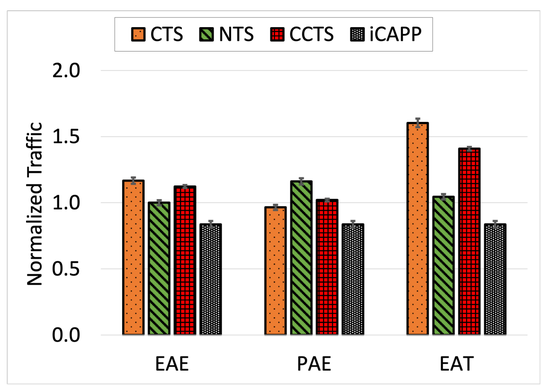
- Implemented iCAPP on Apache Flink

Evaluation

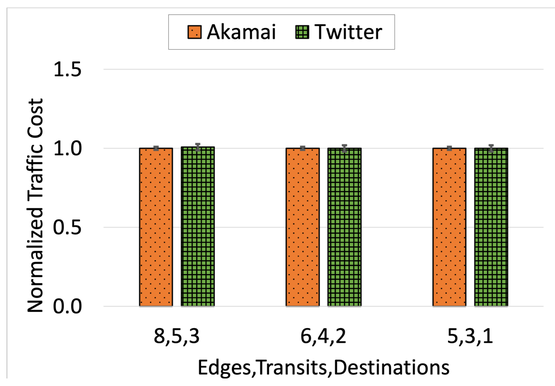
- **Datasets:**
  - Month-long Akamai trace download analytics trace
  - Three-day Twitter trace
- **Deployment:** Geo-distributed testbed using AWS EC2
- Baselines representing state-of-the-art GDA frameworks

4. Experimental Results

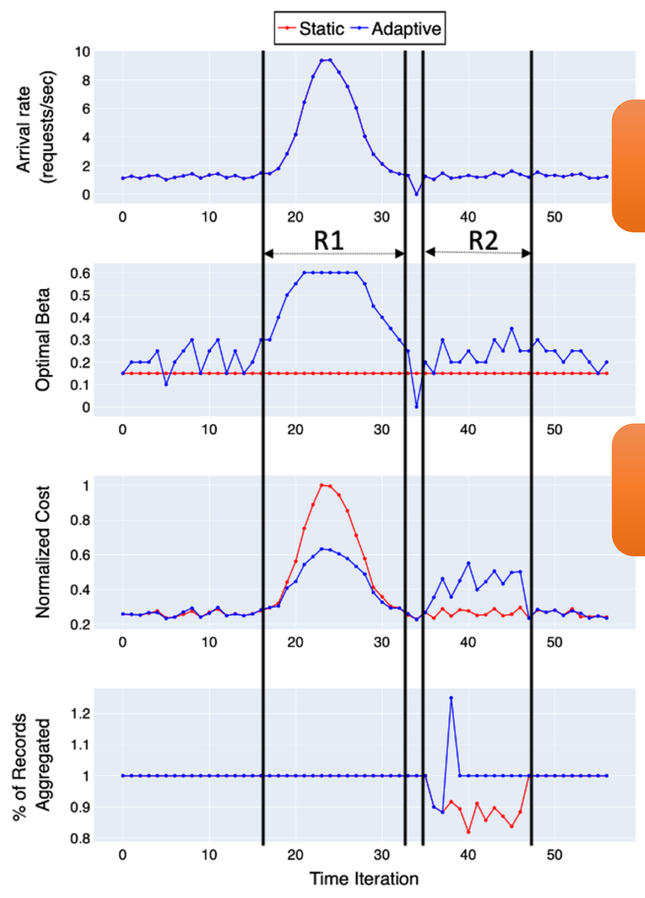




iCAPP improves **traffic cost** by up to **83%** without increase in traffic



iCAPP **within 1%** of optimal



Responsive to workload variation

Robust in case of link failures