

BEYOND NETWORK SELECTION: EXPLOITING ACCESS NETWORK HETERO- GENEITY WITH NAMED DATA NETWORKING

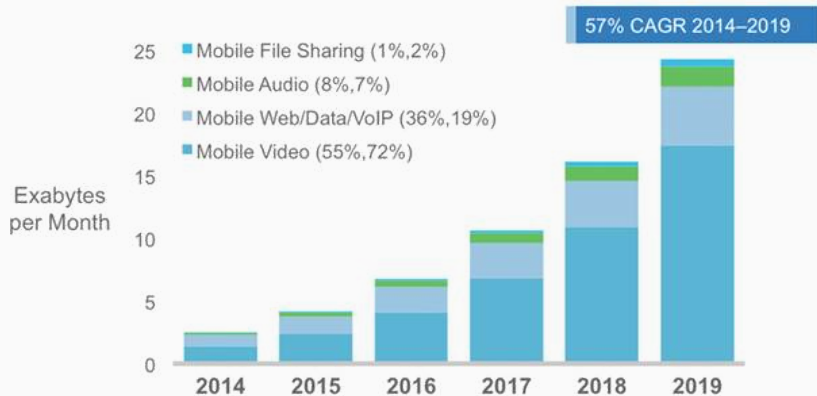
2nd ACM Conference on Information-Centric Networking

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October 2, 2015

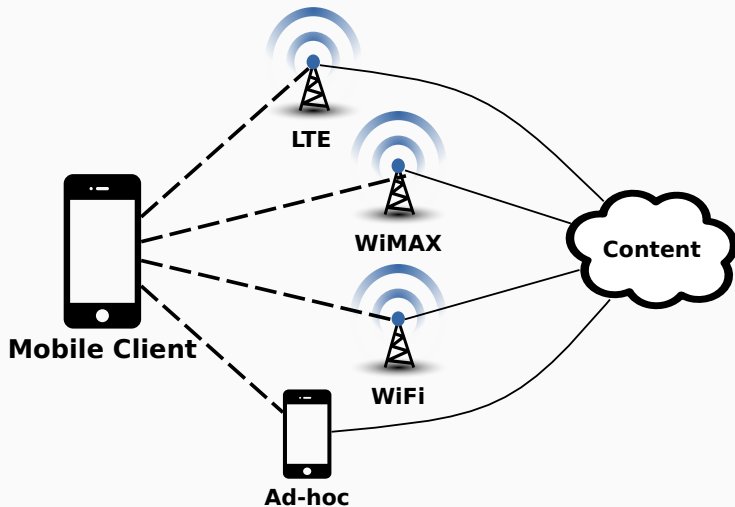
University of Bamberg, Germany

TWO TRENDS: CONTENT & MOBILITY



Source: Cisco VNI Mobile, 2015

MULTIHOMED TERMINAL SCENARIO

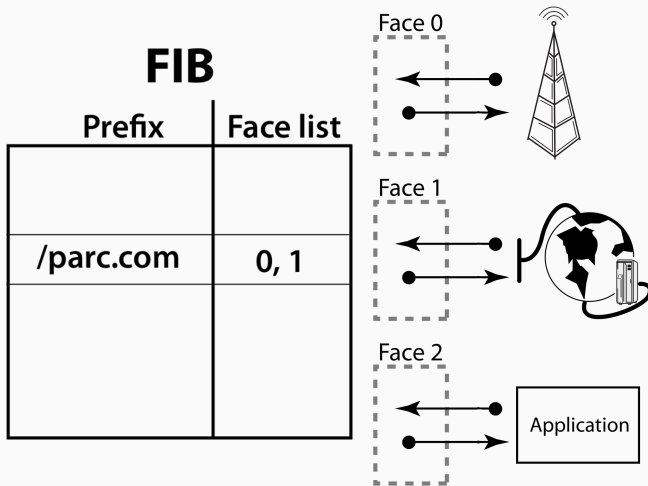


Common Observations

1. Different Application Requirements
2. Different Access Network Characteristics
3. Different Cost Factors

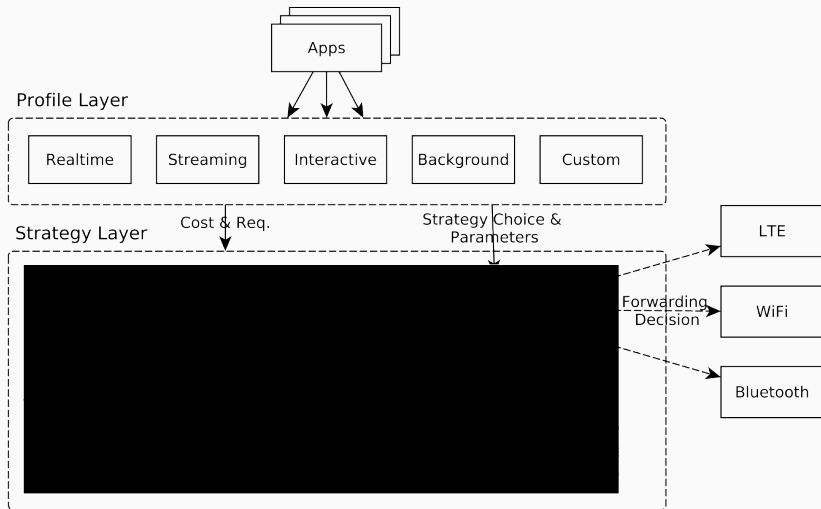
Goal: Doing better than IP Network Selection

SOLUTION: STATEFUL & ADAPTIVE FORWARDING!



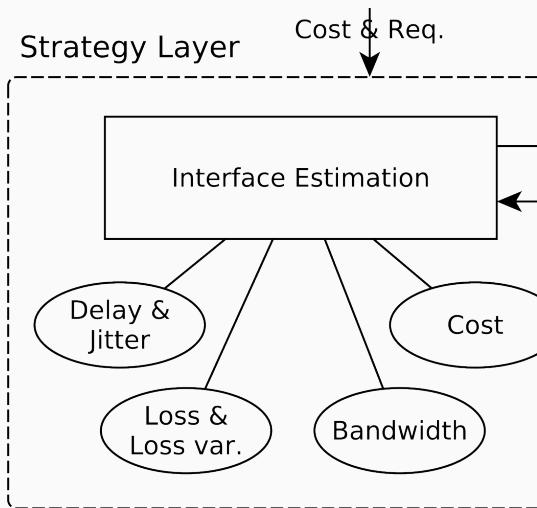
Source: Van Jacobson et al. - Networking Named Content (2009)

SYSTEM ARCHITECTURE & DESIGN

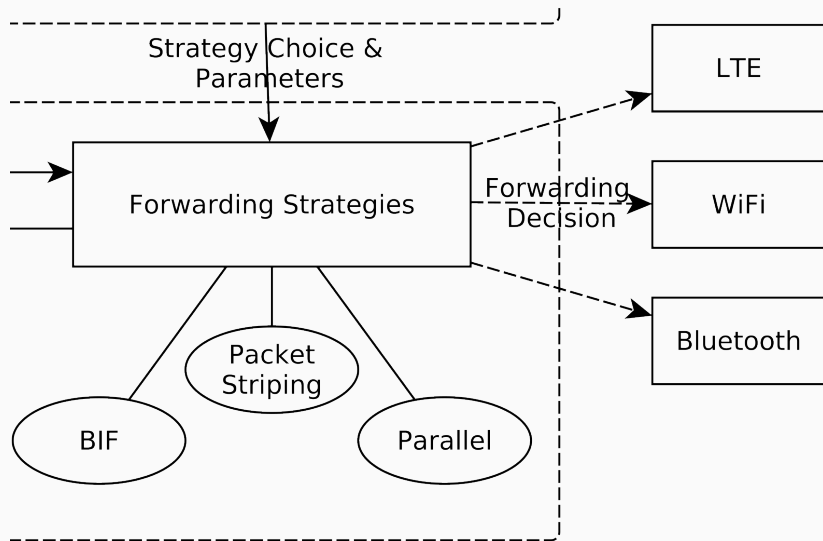


SYSTEM ARCHITECTURE – INTERFACE ESTIMATION

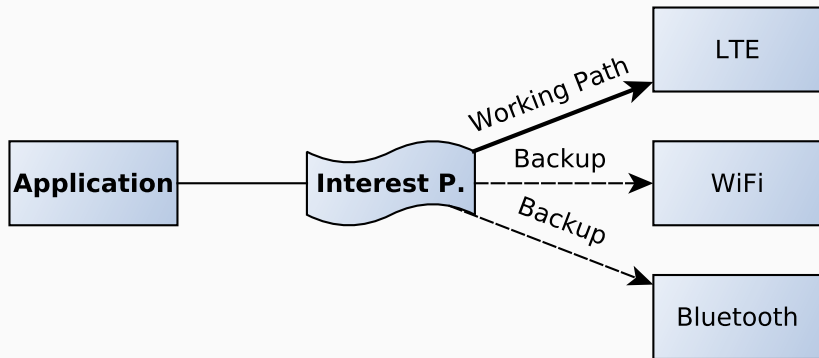
1. Passive Monitoring
 2. Active Probing
- Moving Average



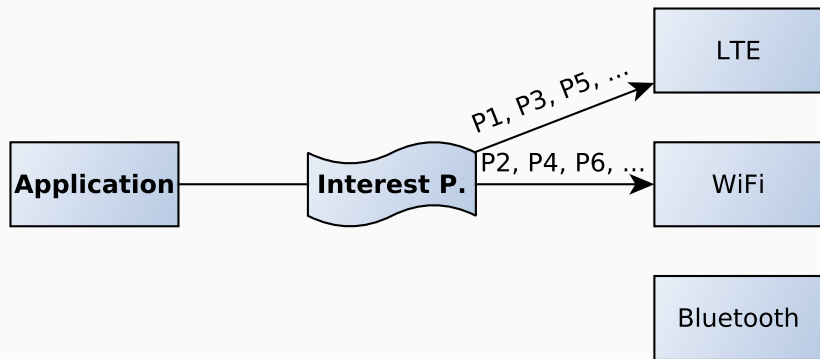
SYSTEM ARCHITECTURE – FORWARDING STRATEGIES



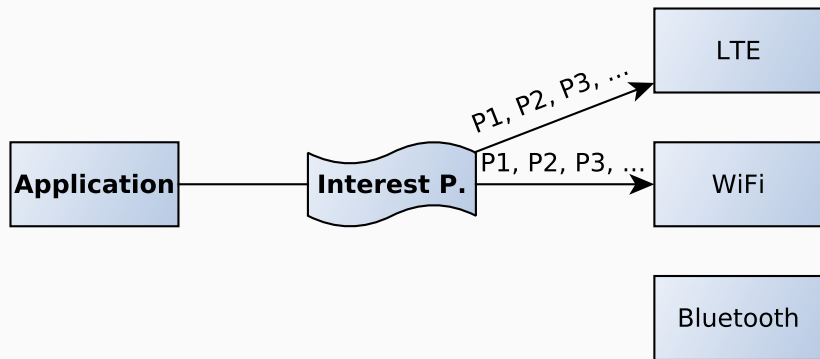
STRATEGIES - BEST INTERFACE FIRST



STRATEGIES - PACKET STRIPING



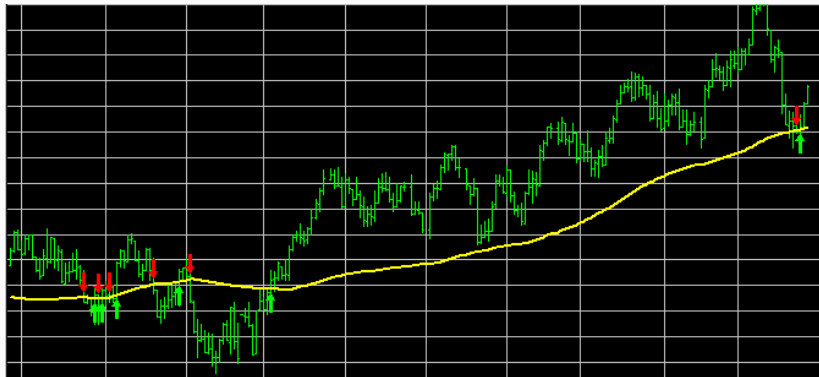
STRATEGIES - PARALLEL TRANSMISSION



Implementation & Evaluation

DELAY ESTIMATOR

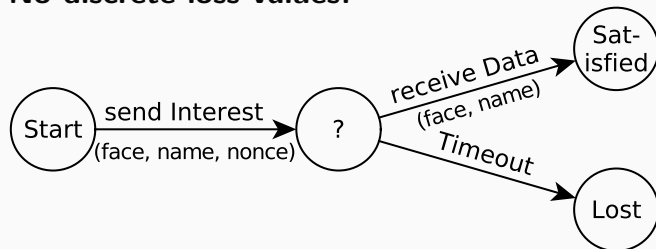
= TCP RTT Estimator



→ Exponential Moving Average

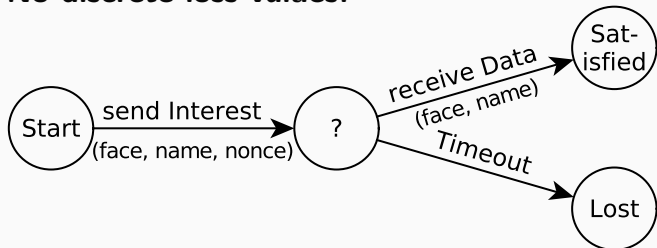
LOSS ESTIMATOR

No discrete loss values!



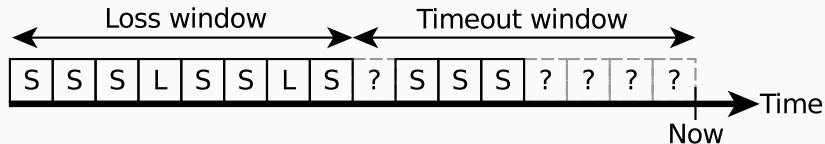
LOSS ESTIMATOR

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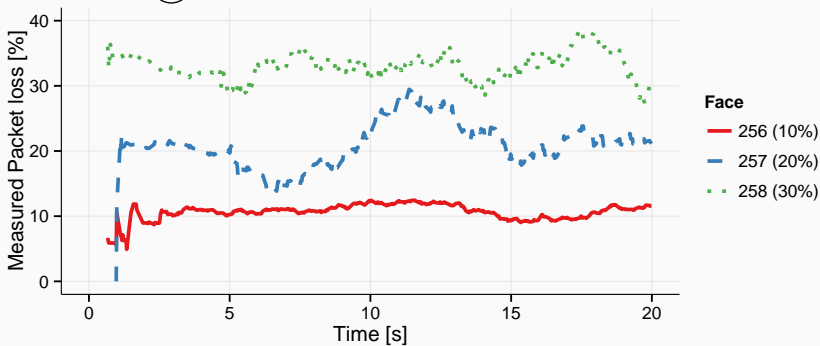
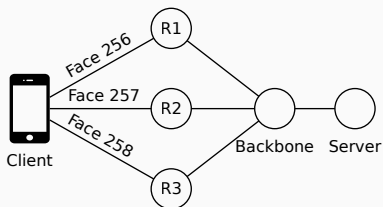


Own Loss Estimator Design!

Based on Simple Moving Average



LOSS ESTIMATOR – MEASUREMENT RESULTS



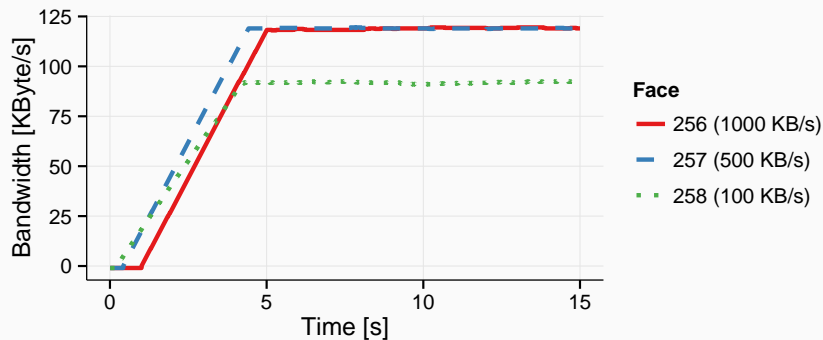
Uniform Packet Loss

BANDWIDTH ESTIMATOR

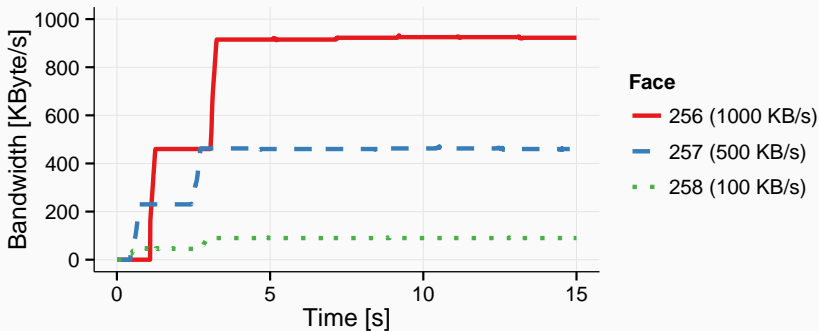
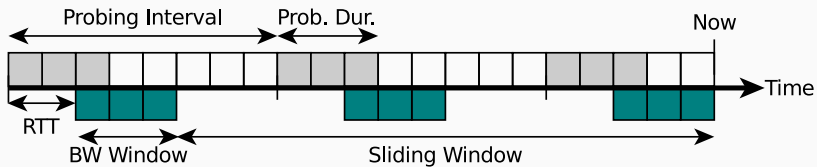
Naive bandwidth probing of *unused paths*

→ **Too much overhead!**

1. Passive Bandwidth Estimation



BANDWIDTH ESTIMATOR – 2. BURST ESTIMATION



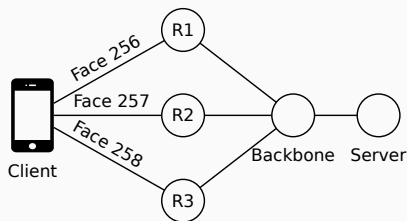
LOWEST COST STRATEGY

Chooses *lowest cost face* that satisfies *all* requirements!

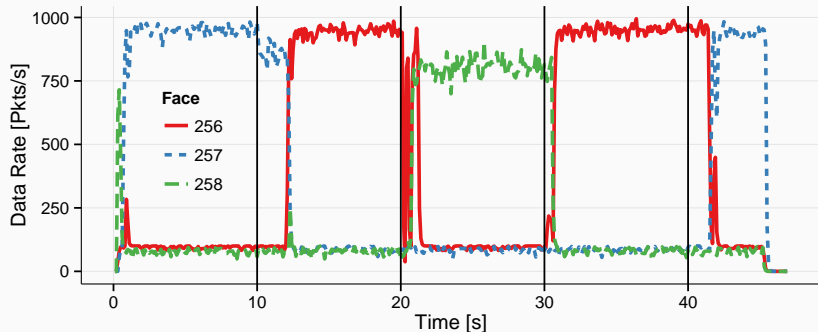
Requirements: maxloss, maxdelay, minbw

Cost: Ordinal attribute

Example: maxdelay=500ms, maxloss=10%, prio=delay



LOWEST COST STRATEGY – MEASUREMENT RESULTS



10 sec: Loss deterioration of path 257

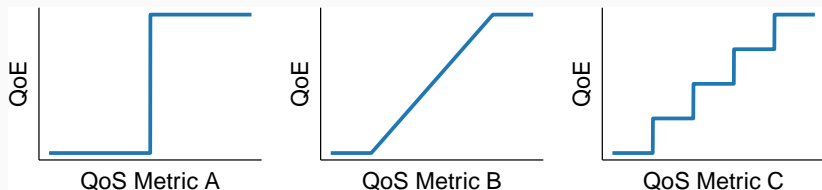
20 sec: Delay deterioration of path 256

30 sec: Delay recovery

40 sec: Loss recovery

Multiple Attributes + Chooses Highest Value Interface

More flexible requirements:



Two thresholds: *Min* and *Max*

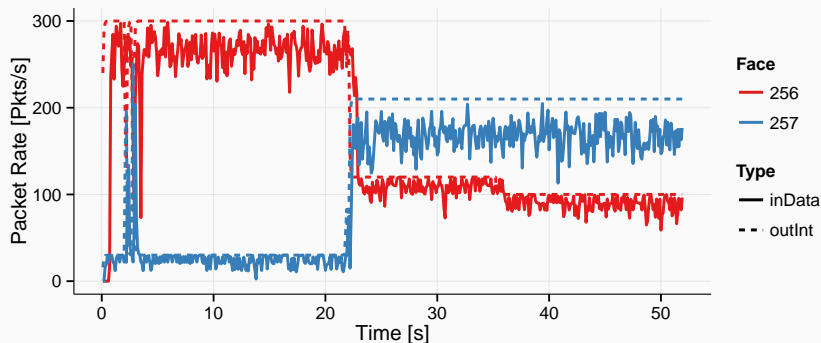
Example: $\text{delay}=20\text{ms}-50\text{ms}$, $\text{cost}_1=10-20$, $\text{cost}_2=2-5$

MADM STRATEGY: MOBILE TRAFFIC LIMIT SCENARIO

App1: loss=0%-40%

App2: loss=0%-40%, cost=50%-70%

$$\text{cost} = \frac{t_{\text{consumed}}}{t_{\text{limit}}} \quad (1)$$

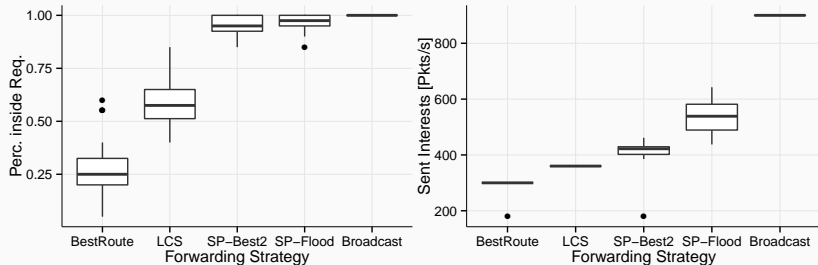


SELECTIVE PARALLEL STRATEGY

Scenario: **Real-time communications!**

SP = LCS + Selective Flooding

1. Req. not met: Flood
2. Req. not met: Use best 2 paths



Adapting NDN to Wireless Multihomed Devices

Interface Estimation (QoS Awareness)

New Adaptive Forwarding Strategies

Future Work

1. Details of Parallel Forwarding Strategies
2. Realistic Evaluation Scenarios
3. Congestion-Control

Thank you for your attention!

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