Congestion Control

Preview Session @SIGCOMM 2015
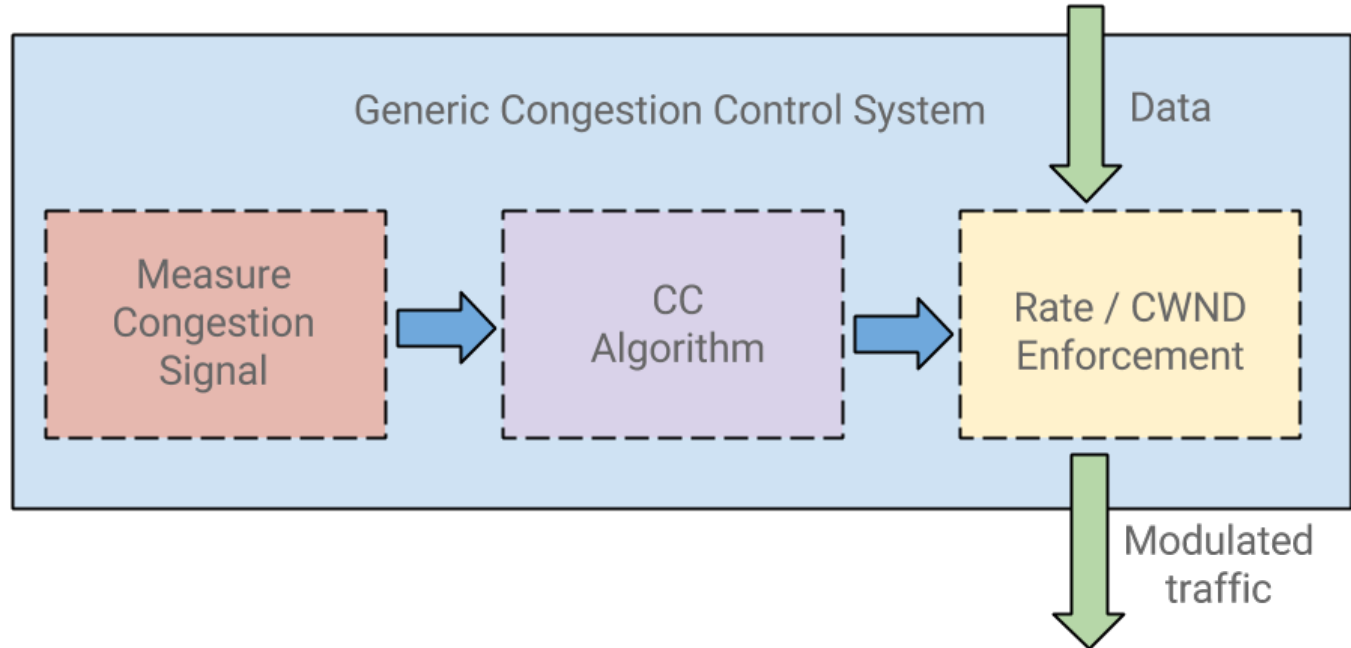
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19 August, 2015

CC: A Fundamental Network Building Block

Fundamental network substates: routing, name resolution, **congestion control**, forwarding, load balancing, ...
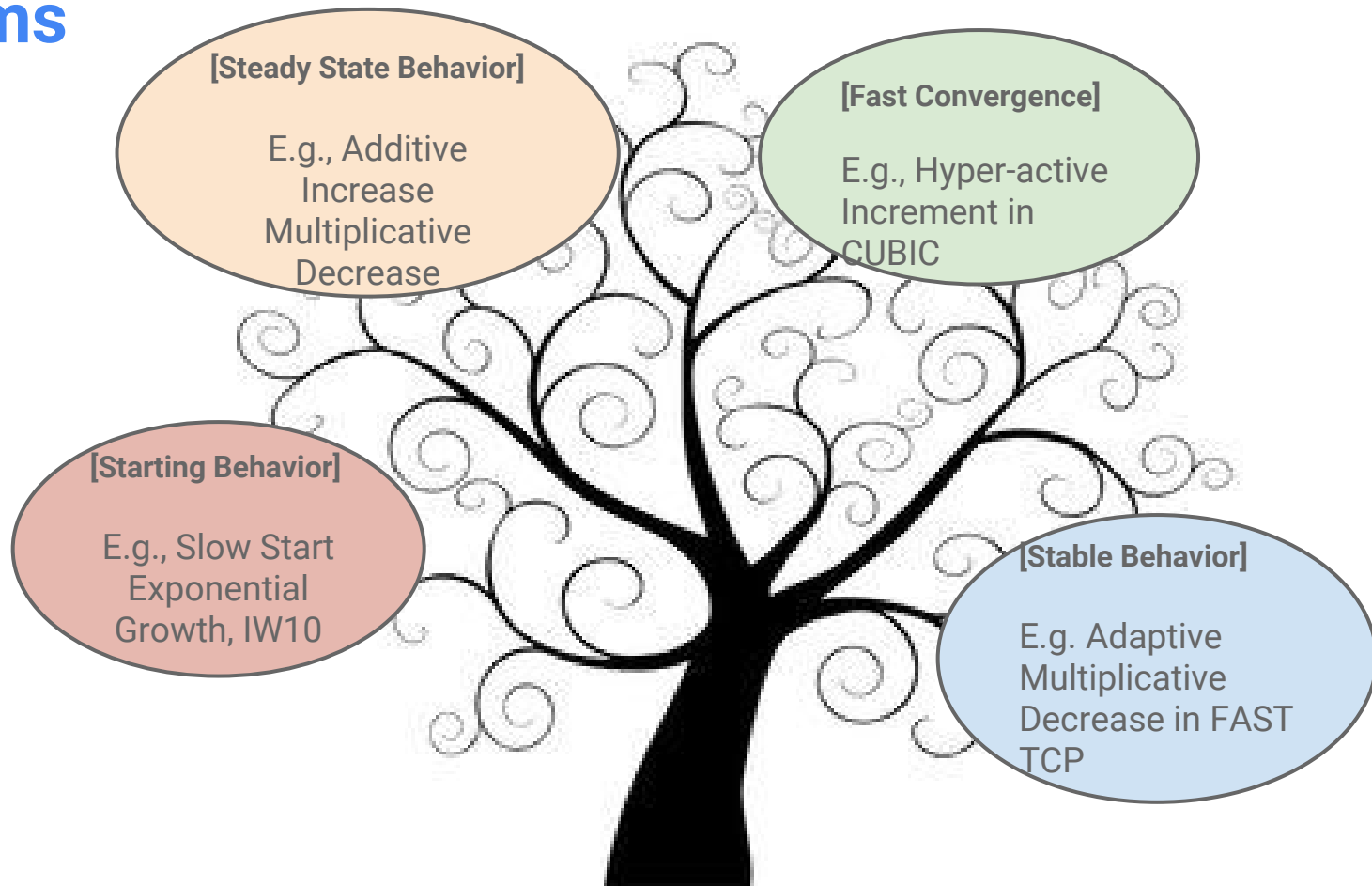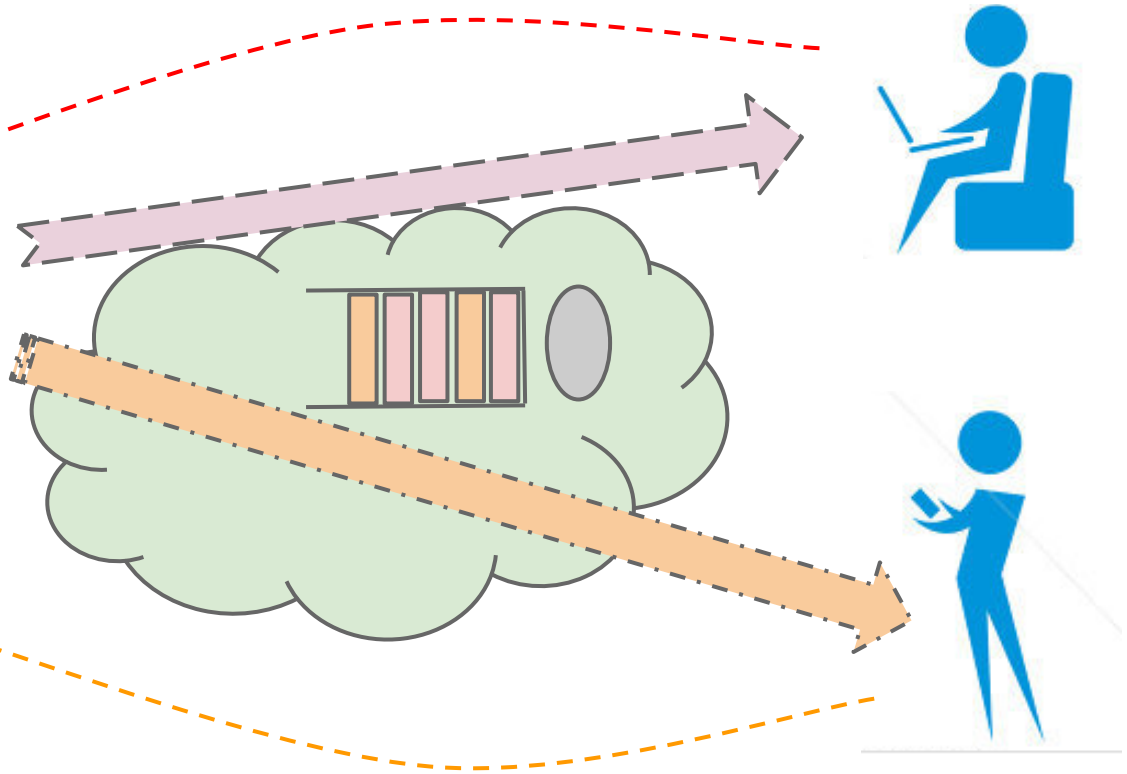
Congestion control system sliced and diced

Generic Congestion Control System

Data

Measure Congestion Signal

CC Algorithm

Rate / CWND Enforcement

Modulated traffic

Google

Signals

End-to-end measured signals	Explicit feedback from network devices
Packet loss	Explicit Congestion Notification (DCTCP)
Round-trip time	Queue delays and differentials (QCN)
Bandwidth estimation	Available bandwidth
Response time	Link utilization
….	….

Algorithms

[Steady State Behavior]

E.g., Additive Increase Multiplicative Decrease

[Fast Convergence]

E.g., Hyper-active Increment in CUBIC

[Starting Behavior]

E.g., Slow Start Exponential Growth, IW10

[Stable Behavior]
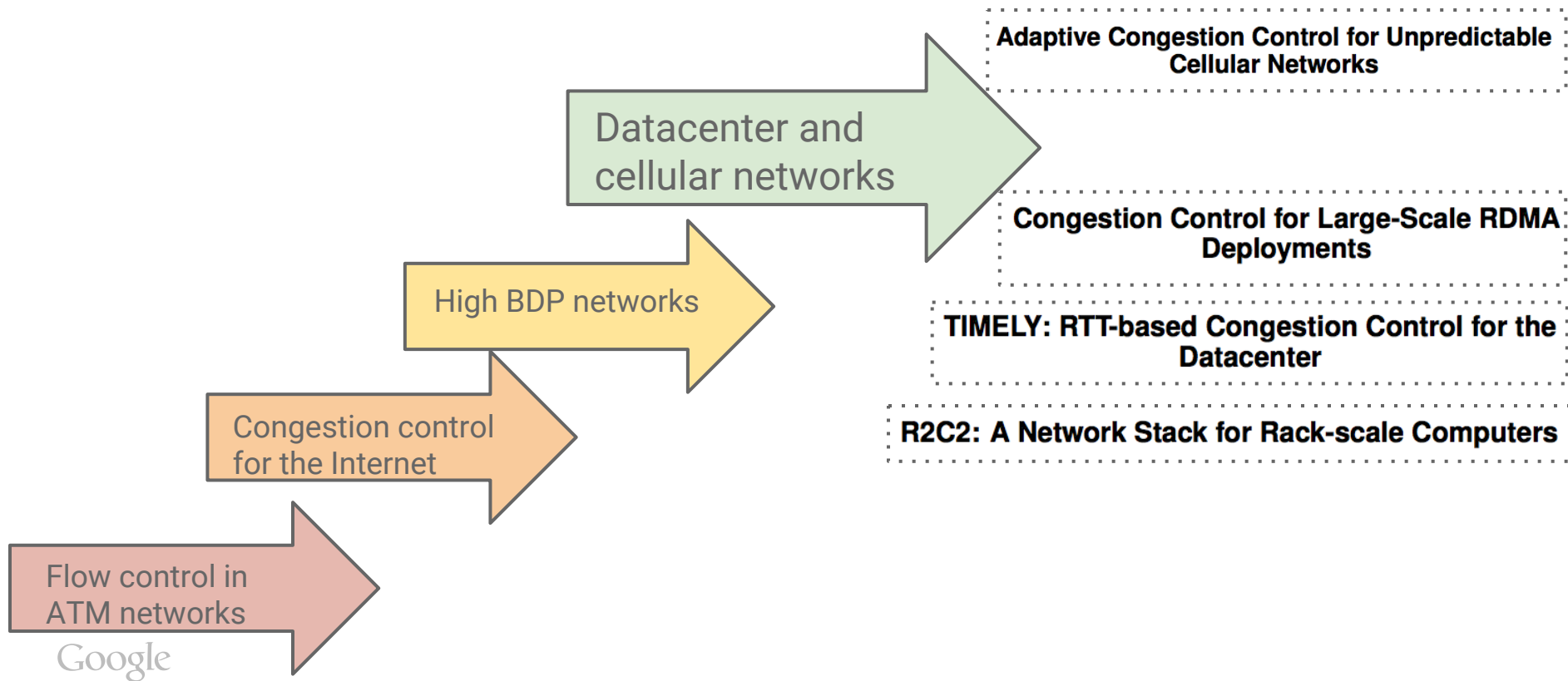
E.g. Adaptive Multiplicative Decrease in FAST TCP

Metrics

[Network centric]
Queue delay, link throughput/goodput, buffer overflows
Bandwidth sharing amongst users
Stability

[User centric]
App. response time
Round-trip time
End-to-end goodput

The Ever Changing CC landscape

Flow control in ATM networks → Congestion control for the Internet → High BDP networks → Datacenter and cellular networks →

- **Adaptive Congestion Control for Unpredictable Cellular Networks**
- **Congestion Control for Large-Scale RDMA Deployments**
- **TIMELY: RTT-based Congestion Control for the Datacenter**
- **R2C2: A Network Stack for Rack-scale Computers**

CC Challenges in Datacenters

Congestion control requirements
    Transfers must complete quickly, low tail latency.
    Deliver high bandwidth (>> Gbps) and low latency (<< ms).
    Efficient use of CPU.

Challenges
    Bursty traffic because of applications and NIC offloading.
    Incast traffic patterns.
    Small buffers.
    Very small round-trip delays.
    Kernel bypassed transports.

Opportunities
    Hardware assistance.
    Less worries of interoperability with legacy.
    Centralized control is possible.

CC Challenges in Mobile Networks

User visible problems
    Variable throughput, delay and application performance.

Fundamental challenge
    Mismatch in TCP's design and underlying link layer channel.
    e.g., channel bandwidth is time varying and unpredictable, deep per-user
    buffers, burst scheduling algorithms.

Take Away Exercise

Evaluate each of the works in the CC session on these four dimensions Signals, Algorithms, Enforcement Mechanism, Metrics.