# Falloc: Fair network bandwidth allocation in IaaS datacenters via a bargaining game approach

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# Outline

Background

Existing Cloud Services Structure

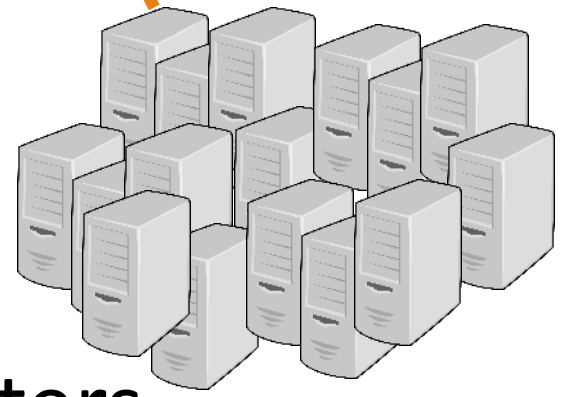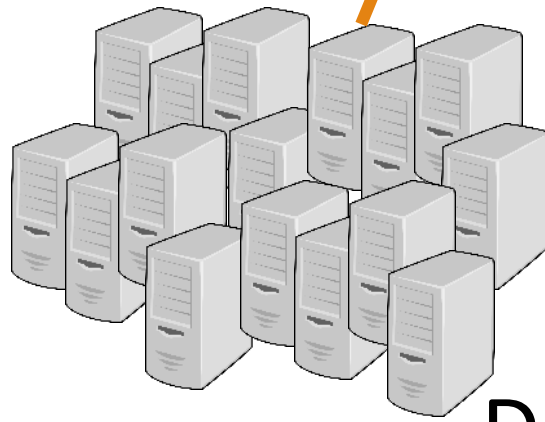Issues

Model

Solution

# Background

Requests

Cloud

Data centers
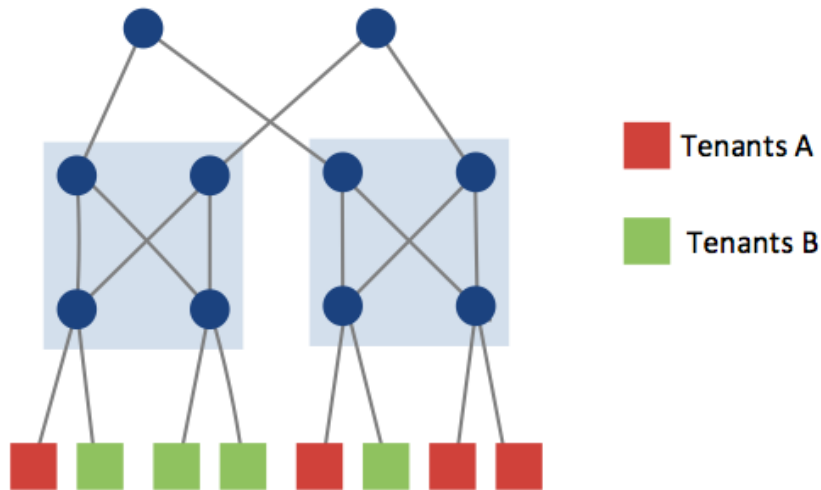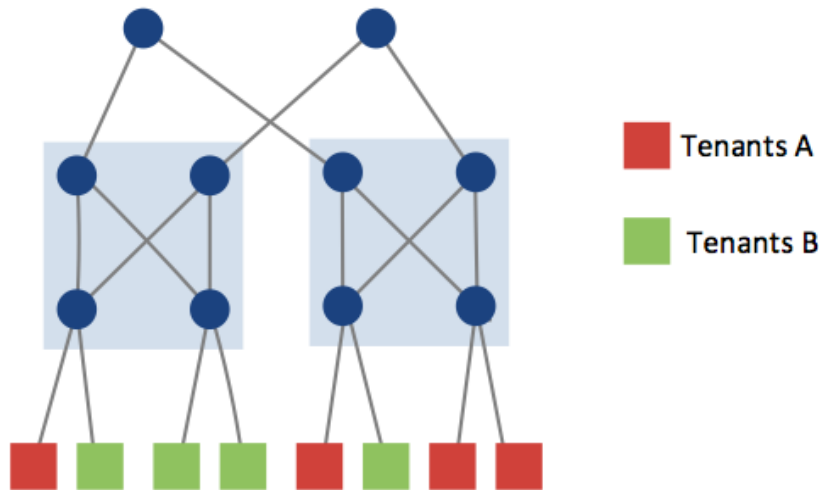
# Existing Congestion Control



on Servers

and

Rely on TCP

# Existing Congestion Control



We need better bandwidth control which means in VMs rather than servers

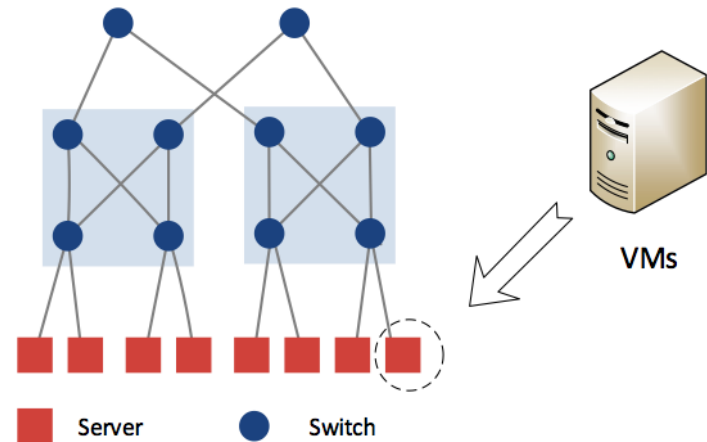# Bandwidth Guarantee

For ensure the availability.

Users need a bandwidth guarantee

Question:
◦ How much does a user need?



VMs

Server    Switch

# Bandwidth requirement is uncertain



time-varying
↓
uncertain

t1   t2
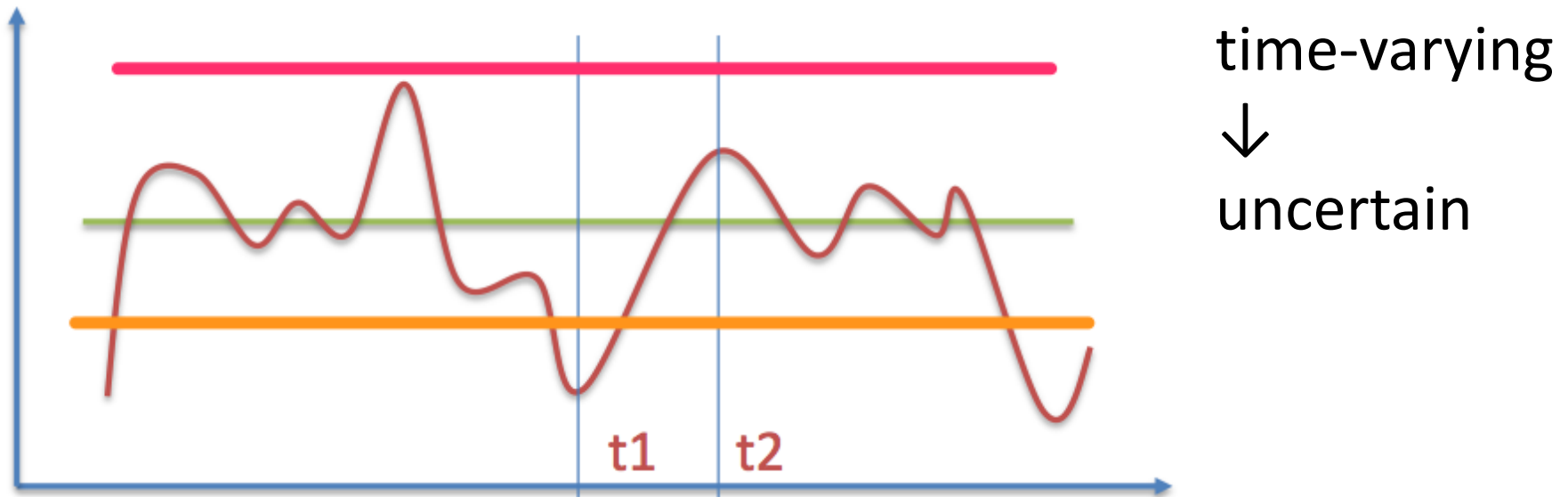
statically reserved → low utilization

# Provider and User Want

1. better congestion control (on VMs)

2. provide bandwidth guarantee

3. improve utilization

# Better Congestion Control

Existing Work

Virtual Cluster

Virtual Cluster

◦ Oktopus, SIGCOMM'2011

◦ Ballani, H., Costa, P., Karagiannis, T., & Rowstron, A. (2011, August). **Towards predictable datacenter networks**

reserve static bandwidth ⟶ decrease utilization

# Bandwidth Guarantee



Base bandwidth: B
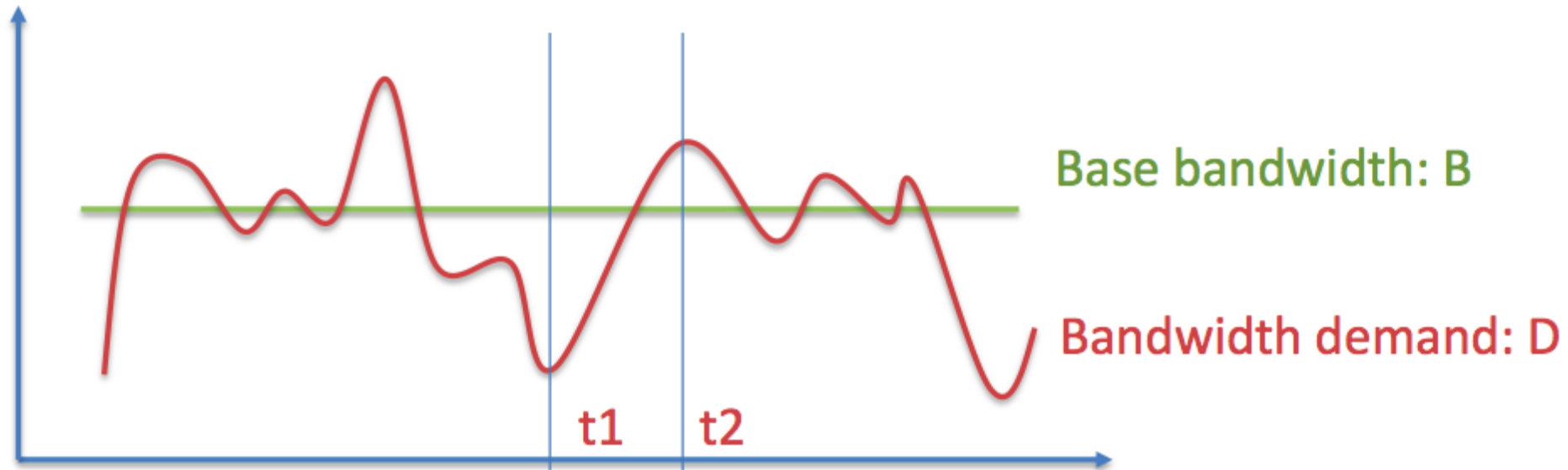
Bandwidth demand: D

Choose a base bandwidth

# Improve Utilization

How to improve:
1. Choose a proper base bandwidth
2. Compete some bandwidth
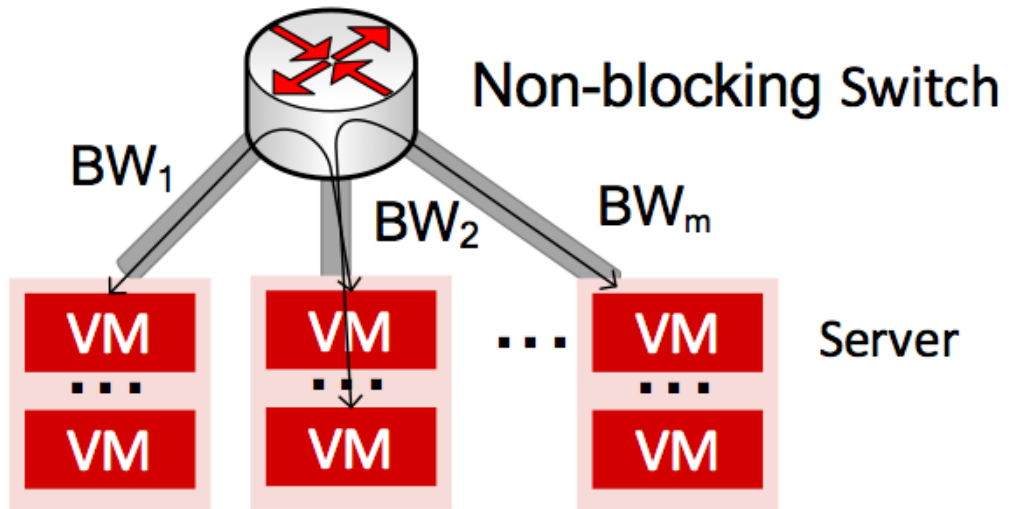3. Distinguish bandwidth demands by **priority**

a better
congestion control

# Requirements

1. work on VMs

2. dynamically choose a base bandwidth for guarantee

3. distinguish different bandwidth demands by priority

4. improve utilization

# Model



users:
  requirement:
  weight

cloud provider:
  capacity

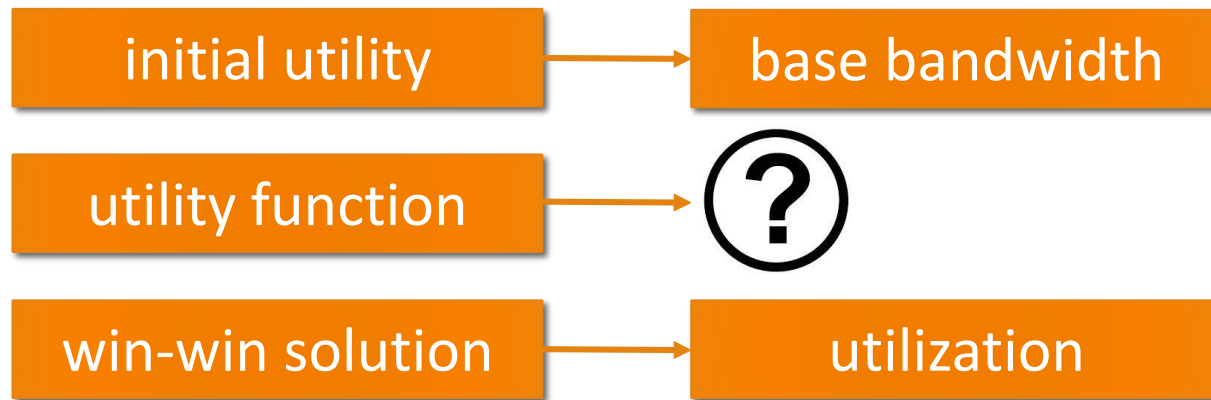# Nash Bargaining Game

Why?

In Nash Bargaining Game:

1. two or more users
2. has a initial utility
3. has a utility function
4. cooperate for a <span style="color:red">win-win solution</span>

↓

Pareto Optimal

# How to Formulate?

| | |
|---|---|
| initial utility | → | base bandwidth |
| utility function | → | ? |
| win-win solution | → | utilization |

# Base Bandwidth

$$B_{i,j} = \min\{B_i^E \frac{K_i}{\sum_{D_{ik}\neq 0, k\in\mathcal{N}} K_k}, B_j^I \frac{K_j}{\sum_{D_{kj}\neq 0, k\in\mathcal{N}} K_k}\}$$

$$K_{i,j} = \frac{K_i}{\sum_{D_{ik}\neq 0, k\in\mathcal{N}} 1} + \frac{K_j}{\sum_{D_{kj}\neq 0, k\in\mathcal{N}} 1}$$

# Utility Function

How to define the utility function in Nash Bargaining Game?

We have information about bandwidth demands

We know:

bandwidth demands

weight

Our goal:

satisfied more user demands

# Utility Function

$$\max_{r_{i,j}} \prod (r_{i,j} - L_{i,j})^{K_{i,j}}, \forall r_{i,j} \in J.$$

# Easier Objective Function

$$\max_{r_{i,j}} \quad \sum_{j}\sum_{i} K_{i,j} \, \ln(r_{i,j} - L_{i,j}), \forall r_{i,j} \in J$$

$$\text{s.t.} \quad L_{i,j} \leq r_{i,j} \leq U_{i,j}, \ \forall i,j \in \mathcal{N}$$

$$\sum_{i \in V_m} r_i^I \leq C_m \ \forall m \in \mathcal{M}$$

$$\sum_{i \in V_m} r_i^E \leq C_m, \ \forall m \in \mathcal{M},$$

# Centralized Solution

Data Center Model + Nash Bargaining Game
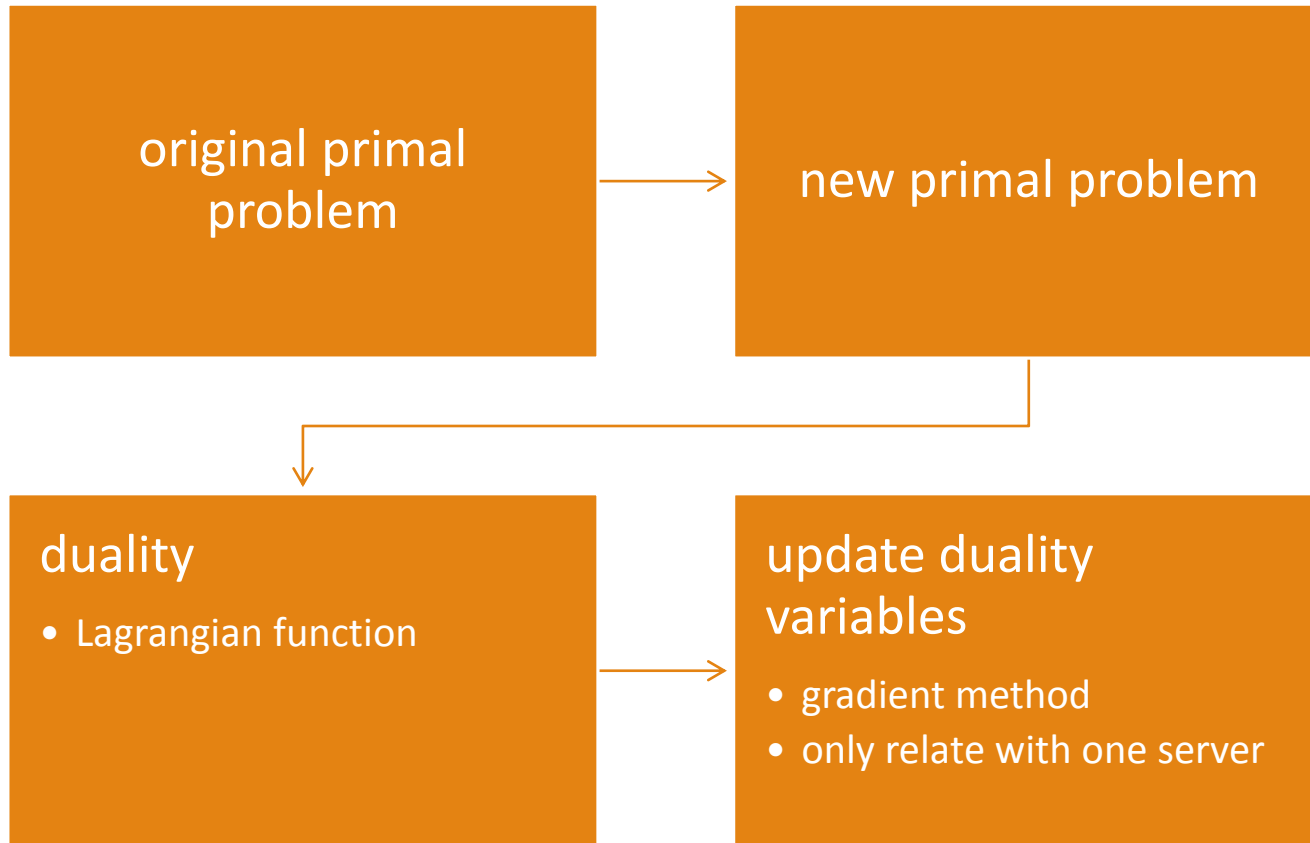
↓

objective function (primal problem)

↓

duality

↓

centralized solution

# Distributed Solution

original primal problem → new primal problem

duality
- Lagrangian function

→ update duality variables
- gradient method
- only relate with one server

# Why two solutions?

## Centralized Solution

- SDN data center

## Distributed Solution

- traditional data center