Distributed Placement of Service Facilities in Large-Scale Networks

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Overview

"How can we determine in a distributed and scalable manner the *number* and *location* of service facilities?" We propose an innovative approach in which topology and demand information is limited to neighborhoods, or balls of small radius around selected facilities, whereas demand information is captured implicitly for the remaining (remote) clients outside these neighborhoods, by mapping them to clients on the edge of the neighborhood. Through an iterative local reoptimization of the location and the number of facilities within such balls, our distributed approach achieves performance that is comparable to that of optimal, centralized approaches requiring full topology and demand information. We demonstrate the efficiency and scalability of our framework under various synthetic and real Internet topologies.

Background : Centralized Service Deployment

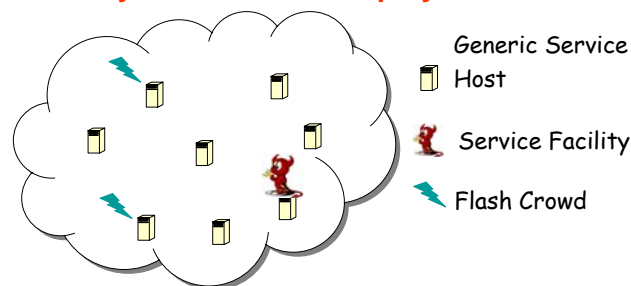**Problem: Estimate the number and location of servers for an application**

- ***Uncapacitated k-median*:**

$$\text{min} \quad C(V,s,k) = \sum_{\forall v_j \in V} s(v_j) \cdot d(v_j, m(v_j))$$

- ***Uncapacitated Facility Location:*:**

$$\text{min} \quad C(V,s,f) = \sum_{\forall v_j \in F} f(v_j) + \sum_{\forall v_j \in V} s(v_j) \cdot d(v_j, m(v_j))$$

Toward Dynamic Service Deployment

Generic Service Host
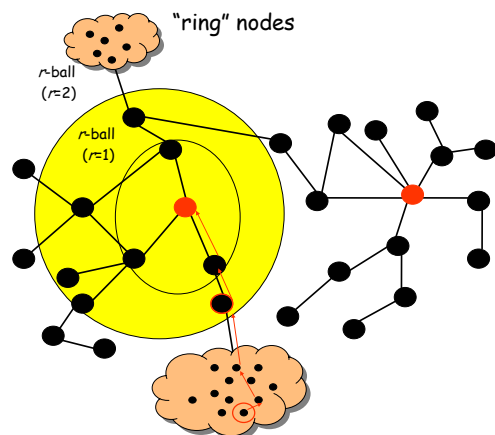
Service Facility

Flash Crowd

Key applications:
- **Distribution of software updates and patches**
- **Real time distribution of virus definitions files**

Key Challenges

An ideal deployment should be:

- **Scalable**

- **Distributed**

- **Oblivious to Network Topology**

- **Unaware (a-priori) of the client demand**

- **Easily Reconfigurable**

A Limited Horizon Approach to Distributed Facility Location

"ring" nodes
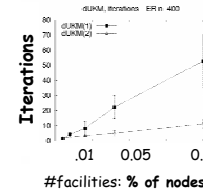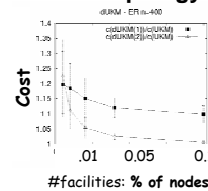
r-ball (r=2)

r-ball (r=1)
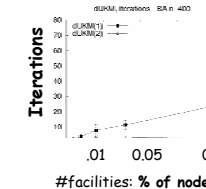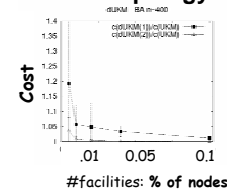
Properties:

1. **Convergence in $O(log_{1+a} n)$ steps**

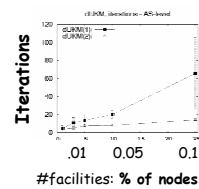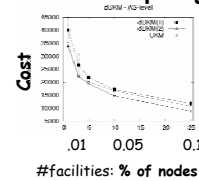2. **The decision of the value for radius r regulates the trade-off between Scalability and Performance**

ER, BA and AS-level coverage with n=497 nodes
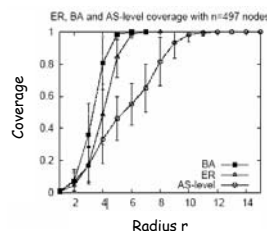
ER topology

BA topology

AS-level topology

Publications:
[1] **"Distributed Placement of Service Facilities in Large-Scale Networks"** Nikolaos Laoutaris, Georgios Smaragdakis, Konstantinos Oikonomou, Ioannis Stavrakakis and Azer Bestavros. IEEE INFOCOM 2007