LEISURE Load-Balanced Network-wide Traffic Measurement and Monitor Placement[2015 LEISURE]

LEISURE FRAMEWORK

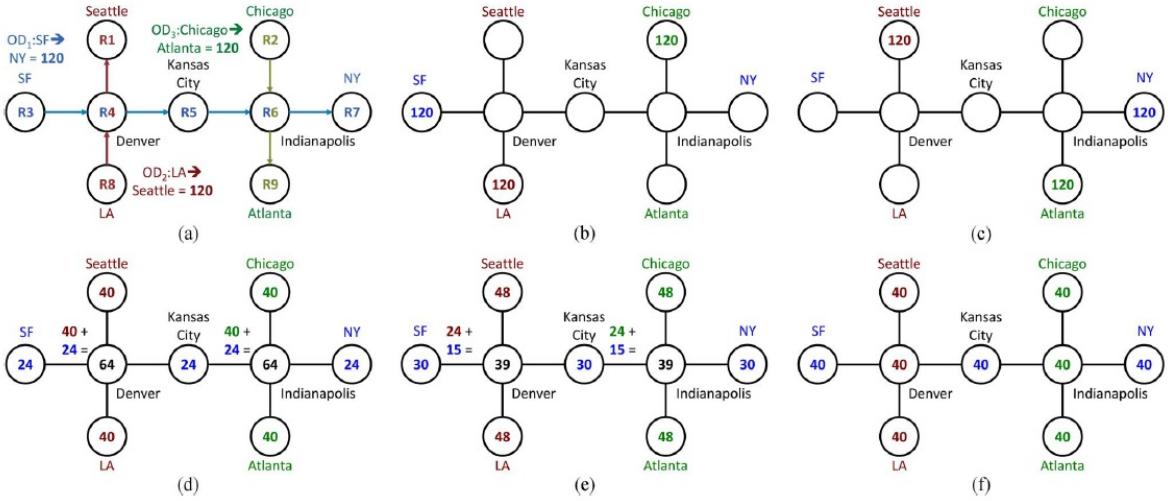
1. INTRODUCTION

Contribution

- 提出LEISURE，公式化全网流量测量负载均衡优化问题，启发式解决方案
  - 有限的测量点资源，有限的测量点数量，多路由路径
- 将LEISURE公式化为混合整数二次规划(MIQP)问题，并通过解耦两个决策变量，将其转化为标准混合整数线性规划问题
- 基于Abilence,GEANT网络拓扑于流量，评估算法效果
  - 单点最大网络负载，所有测量点的负载方差(测量任务均匀分布假设下)

2. MOTIVATING EXAMPLE

利用Example说明网络负载均衡问题



- 样例假设：
  - 3 OD-pairs(each with 120 units of traffic):
  - SF->NY | LA->Seattle | Chicago->Atlanta
- 解决方法：
  i. 在入/出口路由器测量(图中b,c方法)：数量少，但负载高，worst-case(peak 120 units)
  ii. 将负载均分到沿路的测量点(图d方法)：数量多，负载有多又少(出现在多个路径上的负载高)
  iii. 引入负载均衡，按比例计算(图e方法)：进一步减小负载
  iv. 进一步优化，全局负载均衡(图f方法)：数量与负载均有减小。哪些节点参与哪些任务，每个节点该负责任务的比例

3. LEISURE FRAMEWORK

问题公式化与解决方案

- 前置条件

    - ISP通常根据 **源/目的对(OD-pairs)** 定义全网测量任务
- LEISURE
    - 测量任务定义，需要考虑流量需求、路由信息
    - 网络拓扑，流量需求，路由矩阵，测量消耗
    - 中心化的架构
    - 假设：
    - 每个路由器均具备测量功能
    - 每个OD-pair遵循最短路径算法(OSPF)
    - 每个测量点仅执行一种测量任务
- Basic Model
    - Network Topology: $G(V,E)$
    - Set of routers(monitors): V
    - Set of directed links: E
    - Router resource constraint(the number of flows that router V_i can measure in a given measurement interval): $C_{v_{i}}(i=1…M)$
    - OD-pair: $OD_{x},x\in|V|\times|V-1|$
    - set of all OD-pairs: $\Theta=|V|\times|V-1|$
    - traffic demand(IP flows) of OD-pair OD_x: $\phi_x, x\in\Theta$
    - routing strategy for every OD-pair OD_x: $P_x, x\in\Theta$
    - coverage fraction of IP flows of OD_x that is required to measure: a_x
    - total required measurement traffic: $\beta=\sum_{x\in\Theta}\phi_x\times a_x$
    - fraction of traffic demand of OD_x: d_{i}^{x}
    - the total traffic that router V_i measures for all OD-pairs: L_i
- Problem Formulation
    - min-VAR
    - min-MAX
    - min-VAR-given-MAX
- Optimal/Heuristic Solutions
    - 二次规划QP: for min-VAR
    - 线性规划LP: for min-MAX
    - LP first QP follow : for min-VAR-given-MAX
    -

	d_3^1	d_4^1	d_5^1	d_6^1	d_7^1	d_1^2	d_4^2	d_8^2	d_2^3	d_6^3	d_9^3	$MAX(L_i)$	$VAR(L_i)$	# of monitors	Decision
LB(ingress)	1	0	0	0	0	0	0	1	1	0	0	120/360	0.025	3	local
LB(egress)	0	0	0	0	1	1	0	0	0	0	1	120/360	0.025	3	local
LB(uniform)	1/5	1/5	1/5	1/5	1/5	1/3	1/3	1/3	1/3	1/3	1/3	64/360	0.00167	9	local
LB(weighted)	1/4	1/8	1/4	1/8	1/4	2/5	1/5	2/5	2/5	1/5	2/5	48/360	0.000484	9	global
LB(optimal)	1/3	0	1/3	0	1/3	1/3	1/3	1/3	1/3	1/3	1/3	40/360	0	9	global

4. MEASUREMENT WITH LIMITED MONITORS

加入资源限制条件

- 起因：实际情况下，不是每个路由器均支持/部署测量算法
- Measurement with fixed monitor deployment problem
- Measurement with flexible monitor deployment problem
    - 混合整数二次规划问题(MIQP) -> MILP

5. PERFORMANCE EVALUATION

仿真设置及效果评估

6. CONCLUSION

总结