**Step 1**

基于SFC，生成抽象SFC树

**实验** 模拟实现多个VNF，实现VNF并行逻辑，计算串行、并行时延。得出并行时延与串行时延的关系。

**Step 2**

结合SFC树与底层拓扑，建模放置问题，设计算法（Greedy, Greedy-optimal, ILP）解决放置问题。

**实验** 模拟生成底层网络拓扑与SFC集合。运行算法对比结果。

TODO：

1. 模拟实现VNF；
2. 并行逻辑实现；
3. 对VNF进行分类，并完成SFC树生成算法；
   1. 1、2、3不能同时并行，但2、3或1、2可以并行时，如何选择？
4. 实现底层拓扑模拟算法，随机生成SFC；
5. 设计放置算法（版本迭代）

## Modeling

|  |  |
| --- | --- |
| **Symbol** | **Description** |
|  | The underlying network topology |
|  | The set of servers. |
|  | The set of links between servers, |
|  | The set of SFC requests |
|  | The set of VNFs of request |
|  | The adjacent matrix that represents the VNF-FG of request . |
|  | 1 if the network data flow needs to be transferred from VNF to VNF ;  0, otherwise. |
|  | The set of VNF dependency of request .  means the network data flow needs to be transferred from VNF to VNF ; |
|  | The quantity of available resources of server |
|  | The resource demand of a VNF instance |
|  | The latency of a VNF instance |
|  | The latency on link |
|  | The available bandwidth resource on link |
|  | The ingress throughput of request |
|  | The upper bound of latency of request |
|  | 1 if VNF of request is placed on server *;*  0, otherwise. |
|  | ~~The server~~ ~~that VNF of request is placed on.~~ |
|  | 1 if request is accepted;  0 otherwise |

## Objective functions:

### 最大request的数量

### 最大throughput

1. 使用FORD-FULKERSON算法算出底层拓扑的最大流；
2. 在最大流的基础上使用0-1背包问题动态规划解决

### 最小latency

## Subjective functions (Constraints):

### Basic Constraints:

### Capacity Constraints:

### Throughput Constraints:

### Network Delay Constraints:

计算延迟：需要重新建模

## Algorithm

### Sample 1

1. Sort requests in increasing order of their rates;
2. Sort nodes in increasing order of their capacities;
3. Check and place.
4. Resort, check and place
5. Resort and iterate from step 3 until there are no remaining requests.

### Sample 2

* Constrained bipartite matching
* Betweenness centrality

## Modeling

|  |  |
| --- | --- |
| **Symbol** | **Description** |
| Topology | |
|  | The underlying network topology |
|  | The set of servers. |
|  | The set of links between servers, |
|  | The latency on link |
|  | The available bandwidth resource on link |
|  | The quantity of available resources of server |
| SFCs | |
|  | The set of SFC requests |
|  | The ingress throughput of request |
|  | The upper bound of latency of request |
|  | The set of VNFs of request |
|  | The set of configurations of SFC request r. |
|  | 1 if ith configuration is selected for request r  0, otherwise. |
|  | 1 if request is accepted;  0 otherwise |
|  | The latency when choosing the configuration for request . |
|  | The computing resources consumption of server s when choosing the configuration i for request r. |
|  | The bandwidth consumption of link e when choosing the configuration i for request r. |

## Objective functions:

### 最大request接受数量，最小latency

## Subjective functions (Constraints):

### Basic Constraints:

### Computing Resource Constraints:

### Bandwidth Constraints:

### Network Delay Constraints:

|  |  |  |
| --- | --- | --- |
|  | **Topology** | **SFC** |
| **Size** | 32~128 | 5~10 |
| **Throughput (Mbps)** | 1000~10000 (edge) | 100~1000 |
| **Computing Resource (Mhz)** | 4000~8000 (node) | 400~800 (VNF) |
| **Latency (ms)** | 2~5 (edge) | 0.2~2 (VNF)  Requirement: 10~30 |

## Modeling

|  |  |
| --- | --- |
| **Symbol** | **Description** |
| Topology | |
|  | The underlying network topology |
|  | The set of servers. |
|  | The set of links between servers, |
|  | The latency on link |
|  | The available bandwidth resource on link |
|  | The quantity of available resources of server |
| SFCs | |
|  | The set of SFC requests |
|  | The ingress throughput of request |
|  | The upper bound of latency of request |
|  | The set of VNFs of request |
|  | The set of configurations of SFC request r. |
|  | 1 if ith configuration is selected for request r  0, otherwise. |
|  | 1 if request is accepted;  0 otherwise |
|  | The latency when choosing the configuration for request . |
|  | The computing resources consumption of server s when choosing the configuration i for request r. |
|  | The bandwidth consumption of link e when choosing the configuration i for request r. |

## Objective functions:

### 最大request接受数量，最小latency

## Subjective functions (Constraints):

### Basic Constraints:

### Computing Resource Constraints:

### Bandwidth Constraints:

### Network Delay Constraints:

1. 画图
   1. Bcube：细节更好
   2. Fat-tree，VL2：单独跑
2. Problem Formulation
3. Algorithm
   1. Heuristic
   2. Greedy