Normal Parameters

PARAMETERS	DEFINITION
F	Set of Contents
V	Set of Nodes
Pr_f	Original Provider of Content f
T	Set of Tasks
C_{size}	Maximum Cacheable Node Size
f_{size}	Size of File f
B_{size}	Maximum Bandwidth Size
T_{now}	Present Synchronized Time
$Original_f$	Time of File f update
$limit_f$	Time limit for file f update
$power_v$	Power Consumption when any request or response is passed through node v
$power_{max}$	Maximum Power constraint
$delay(V_i, V_j)$	Time delay between node V_i, V_j
P_f	Probability that file f is requested

Decision Parameters

Decision Variable	Definition
$X_{f,j}$	Specifies file f is cached in node j or not
$y_{t,v}$	Node v executes task t or not
$z_{t,v}$	Offloading decision
$k_{i,j}^{v,f}$	Specifies there is a path between node i and node j if file f is requested by node v

$q_{v,f}$	Specifies whether file f is requested by node v or not

PROBLEM FORMULATION

The optimization problem is :

minimize
$$\Sigma_{f\in F}\Sigma_{v_i,v_j\in V}q_{i,f}P_f(\,X_{f,j}delay(\,v_i,v_j)+(\,1-X_{f,j})\,delay(\,v_i,pr_f)\,)+\Sigma_{t\in T}\Sigma_{v_i\in V}y_{t,v}z_{t,v}delay(\,v_i,S)$$

Subject to constraints:

1. Sum of probabilities of all files is 1

$$\Sigma_{f\in F}P_f = 1$$

2. The content is definitely present in the original provider

$$\forall i(\,\Sigma_{v\in V}X_{i,v}\geq 1)$$

3. The size should not maximum cacheable node for each node

$$\forall v\in V(\,\Sigma_{f\in F}X_{f,v}f_{size}\leq C_{size})$$

4. Bandwidth Constraint

$$\forall(\,i,j)\in V:(\,\Sigma_{v\in V}\Sigma_{f\in F}q_{v,f}Z_{i,j}^{v,f}f_{s}ize\leq B_{size})$$

5. Content Freshness Constraint

$$\Sigma_{f\in F}\Sigma_{v\in V}X_{f,v}(\,T_{now}-Original_f)\leq limit_f$$

6. Delay Energy Constraint

$$\forall (i, j) \in V : (\Sigma_{v \in V} \Sigma_{f \in F} q_{v,f} Z_{i,j}^{v,f} power_j \leq power_{max})$$

7. Task Offloading Energy Constraint

$$\Sigma_{t \in T} \Sigma_{v \in V} y_{t,v} (z_{t,v} power_s + (1 - z_{t,v}) power_v) \leq power_{max}$$