

Virtual nodes topology

V= 1 and 2

V1= 1 2 3

V2 = 4 5 6 7 8

How is connected each other

[1,*,*]

```

: 1 2 3
1 . 1 1
2 1 . 1
3 1 1 .

```

[2,*,*]

```

: 4 5 6 7 8
4 . 1 0 0 0
5 1 . 0 1 0
6 0 0 . 1 1
7 0 1 1 . 1
8 0 0 1 1 .
;

```

Substrate topology how the topology connected each other

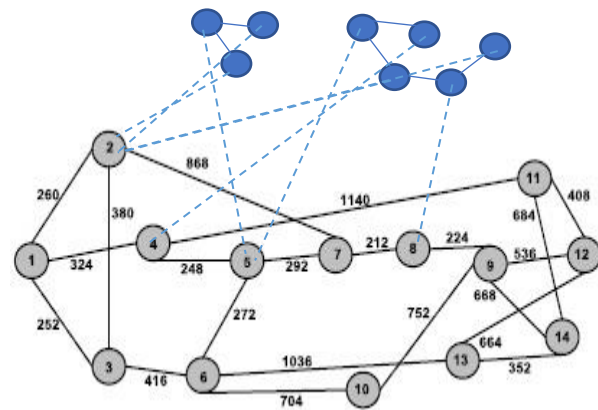
```

N := 1 2 3 4 5 6 7 8 9 10 11 12 13 14;
N[1] := 2 3 4 ;
N[2] := 1 3 7 ;
N[3] := 1 2 6 ;
N[4] := 1 5 11 ;
N[5] := 4 6 7;
N[6] := 3 5 10 13 ;
N[7] := 2 5 8 ;
N[8] := 7 9 ;
N[9] := 8 10 12 14 ;
N[10] := 6 9 ;
N[11] := 4 12 14 ;
N[12] := 9 11 13 ;
N[13] := 6 12 14 ;
N[14] := 9 11 13 ;

```

Physical topology

Virtual topology request
example



How is connected each other distance between nodes by M

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	:=
1	0	260	252	324	0	0	0	0	0	0	0	0	0	0	
2	260	0	380	0	0	0	868	0	0	0	0	0	0	0	
3	252	380	0	0	0	416	0	0	0	0	0	0	0	0	
4	324	0	0	0	248	0	0	0	0	0	1140	0	0	0	
5	0	0	0	248	0	272	292	0	0	0	0	0	0	0	
6	0	0	416	0	272	0	0	0	0	704	0	0	1036	0	
7	0	868	0	0	292	0	0	212	0	0	0	0	0	0	
8	0	0	0	0	0	0	212	0	224	0	0	0	0	0	
9	0	0	0	0	0	0	0	224	0	752	0	536	0	668	
10	0	0	0	0	0	704	0	0	752	0	0	0	0	0	
11	0	0	0	1140	0	0	0	0	0	0	0	408	0	684	
12	0	0	0	0	0	0	0	536	0	408	0	0	664	0	
13	0	0	0	0	0	1036	0	0	0	0	0	664	0	352	
14	0	0	0	0	0	0	0	668	0	684	0	352	0	0	;

I need Virtual nodes topology embedding in nodes in Substrate topology

The Virtual nodes topology requirement to be embedding:

1-Nodes that are not connected in the virtual topology can be grouped in one group and embedded in the same substrate node.

2- Nodes that are connected to each other in virtual topology must belong to different groups in substrate topology

3-The grouping process is only finished when all nodes in the virtual topology have found a group.

4- There may be more than one grouping option. The grouping option that leads to the minimum number of substrate nodes is selected.

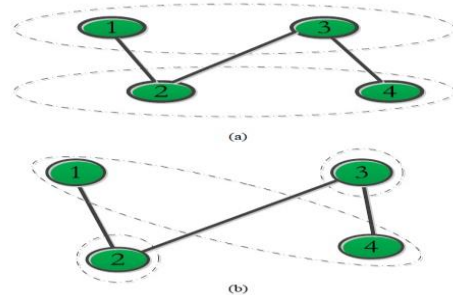
Explain requirement of Virtual nodes in fig

In a (1-3) is not connected each other that's mean

embedded in 1 nodes in substrate node

But a(1-2) connected each other that's mean

Embedded in deferent nodes in substrate node



and also, nodes from a and b could be embedded in same nodes in substrate nodes because deferent network and not connected each other.

We have 3 index

1- for s and d that represent source request and destination request

2- for b and e that node b source for virtual topology and e distention

3- m and n that node m source for substrate topology and n distention

substrate nodes topology has link capacity and CPU processing and inputs data

Max Link capacity = 40 gb for each fiber

Number of fiber= 32

Distance between EDFA (S) =80 m

$A_{mn} = \{ \text{distance} / (S) - 1 \} + 2$ distance you can find in substrate topology by M

F_{mn} = represent number of fiber need based on request of virtual nodes will be variable.

Example = request 99 gb that's mean need 3.09 fiber at least because 1 fiber can hold 40 gb and we need $99 \text{ gb} = 99/32 = 3.09 \text{ fiber}$

Max CPU processing nodes capacity= 100 hz

$P_{\max} = 500 * 365$

$P_{\min} = 500 * 112$

$Q_{mn} = \text{sum} (\text{request of virtual topology links} / \text{Max Link capacity})$

Virtual nodes topology has link capacity and CPU processing request

Max Link capacity request= between 5 to 40 random

Max CPU processing nodes capacity request = 1 to 100 random

You can use this equation $\text{CPU utilization} = \text{Virtual nodes} / \text{substrate nodes}$

Example $\text{CPU utilization} = \text{Virtual nodes request process } 50 / \text{capacity in substrate } 100 = 0.5\%$ utilization from MAX CPU in substrate nodes should be \geq

Even links in virtual nodes \geq Max link in substrate nodes 40

to keep requests of virtual nodes from substrate nodes does not exceed the range of substrate nodes.

(The objective minimizing the power consumption of this network)

Substrate topology power network :

Power consumption of a router, Power consumption of a transponder, Power consumption of an EDFA,

Power consumption of an optical switch= 85 w , Power consumption of a multi/demultiplexer = 16 w, Idle server power consumption = 9 w, Data center server power consumption = $(P_{\max} - P_{\min})/100$, Power consumption of EDFA = 11 w, Power consumption of router = 638 w, Power consumption of transponder = 129 w

How calculated by this equation to minimizing the power :

Power consumption of router * Q_{mn} + sum W_{mn} + sum Power consumption of transponder * W_{mn}

+ Power consumption of EDFA * sum A_{mn} * f_{mn} + Power consumption of an optical switch+ Power consumption of a multi/demultiplexer

+sum virtual nodes topology request process CPU utilization* embedding 1 nodes at substrate topology * Data center server power consumption + Idle server power consumption = 9 w