كليـــة الهنــدســة
College of Engineering
Computer Science Department

جامعة عفت
EFFAT UNIVERSITY

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Spring 2022

Suppose that you are the CEO of a startup deals with network configuration for various companies. You received your first assignment to configure the network for two companies in such a way that all the PCs in each company must be able to communicate with each other as well as with all the PCs of any other company.

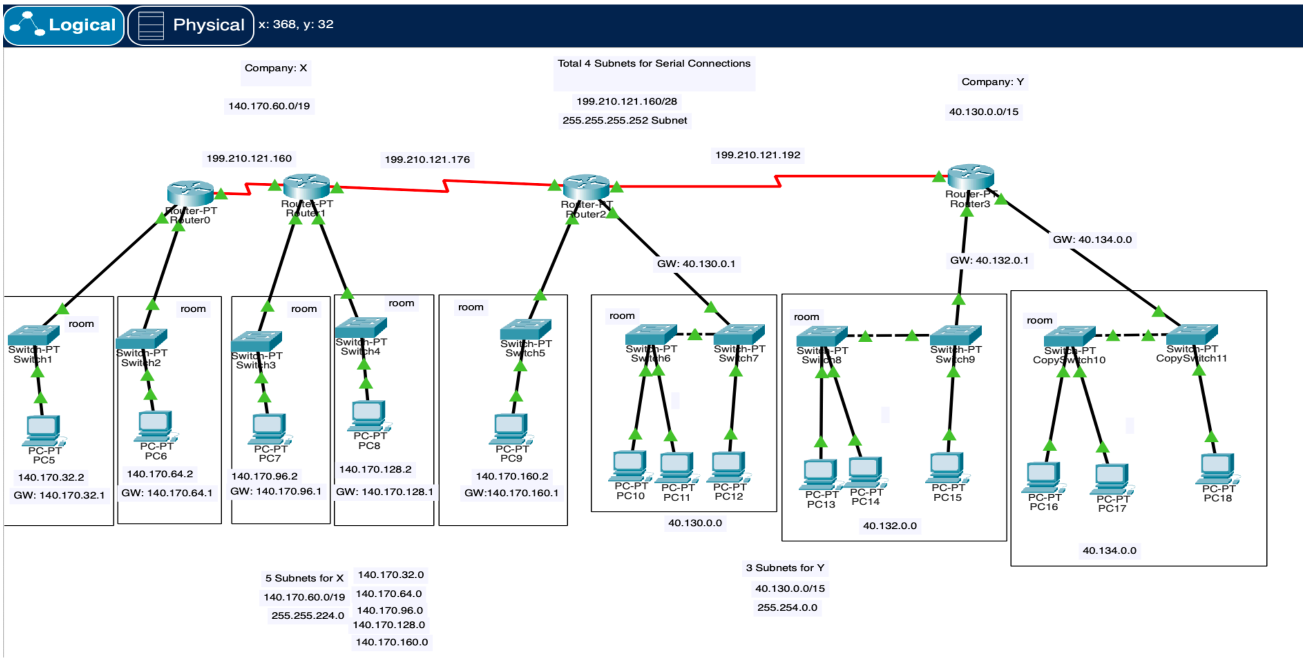
The companies are named as CMP X and CMP Y.

- CMP X has 5 Rooms with 1 PC in each room.
- CMP Y has 3 Rooms with 3 PCs in each room.

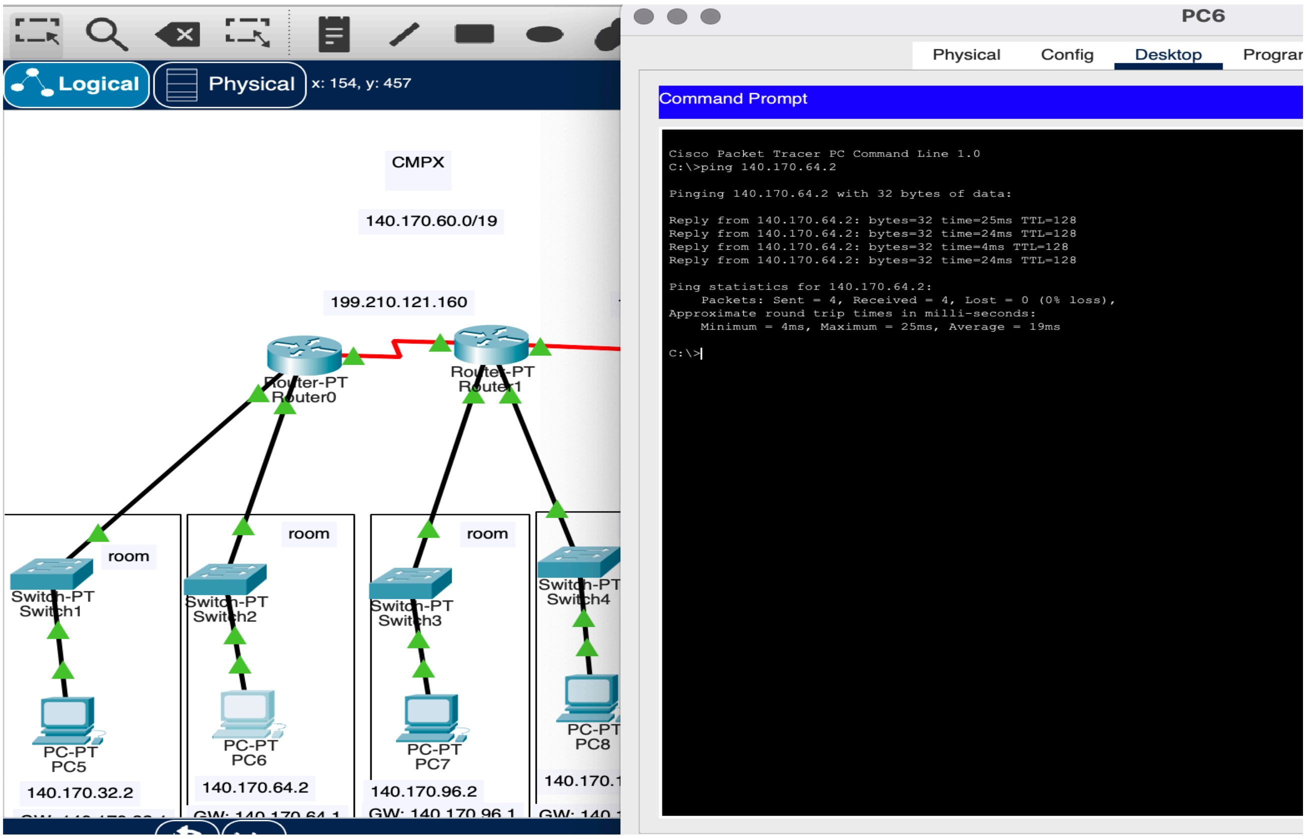
The IP regulating company has assigned the following IP network addresses to each of the company:

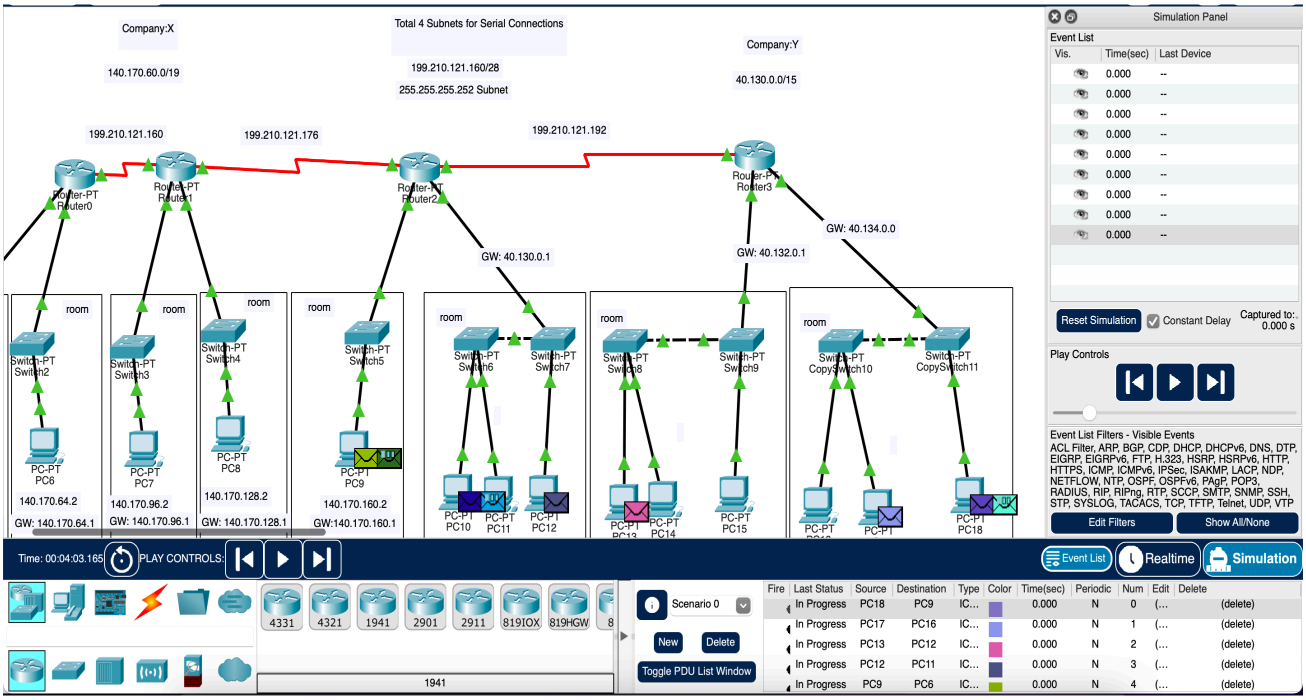
- CMP X: 140.170.60.0/19
- CMP Y: 40.130.0.0/15

Screenshot of the Output:



Kindly Check All rooms for a clear look as everything was successfully Created.


Logical
Physical
x: 154, y: 457
CMPX
140.170.60.0/19
199.210.121.160
Router-PT
Router0
Router-PT
Router1
room
Switch-PT
Switch1
Switch-PT
Switch2
Switch-PT
Switch3
Switch-PT
Switch4
PC-PT
PC5
PC-PT
PC6
PC-PT
PC7
PC-PT
PC8
140.170.32.2
140.170.64.2
140.170.96.2
PC6
Physical
Config
Desktop
Command Prompt
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 140.170.64.2
Pinging 140.170.64.2 with 32 bytes of data:
Reply from 140.170.64.2: bytes=32 time=25ms TTL=128
Reply from 140.170.64.2: bytes=32 time=24ms TTL=128
Reply from 140.170.64.2: bytes=32 time=4ms TTL=128
Reply from 140.170.64.2: bytes=32 time=24ms TTL=128
Ping statistics for 140.170.64.2:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 4ms, Maximum = 25ms, Average = 19ms
C:\>


Company:X
140.170.60.0/19
Total 4 Subnets for Serial Connections
199.210.121.160/28
255.255.255.252 Subnet
Company:Y
40.130.0.0/15
199.210.121.160
199.210.121.176
199.210.121.192
GW: 40.130.0.1
GW: 40.132.0.1
GW: 40.134.0.0
140.170.64.2
140.170.96.2
140.170.128.2
140.170.160.2
GW: 140.170.64.1
GW: 140.170.96.1
GW: 140.170.128.1
GW:140.170.160.1
Simulation Panel
Event List
Reset Simulation
Constant Delay
Play Controls
Event List Filters - Visible Events
Edit Filters
Show All/None
Time: 00:04:03.165
PLAY CONTROLS:
Event List
Realtime
Simulation
Scenario 0
New
Delete
Toggle PDU List Window

Router0

Physical Config CLI Attributes

IOS Command Line Interface

```
Router0>enable
Router0#show run
Building configuration...

Current configuration : 839 bytes
!
version 12.2
no service timestamps log datetime msec
no service timestamps debug datetime msec
no service password-encryption
!
hostname Router0
!
!
!
!
!
!
!
!
ip cef
no ipv6 cef
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 140.170.32.1 255.255.224.0
 duplex auto
 speed auto
!
interface FastEthernet1/0
 ip address 140.170.64.1 255.255.224.0
```

Command+F6 to exit CLI focus

Copy Paste

Router0

Physical Config CLI Attributes

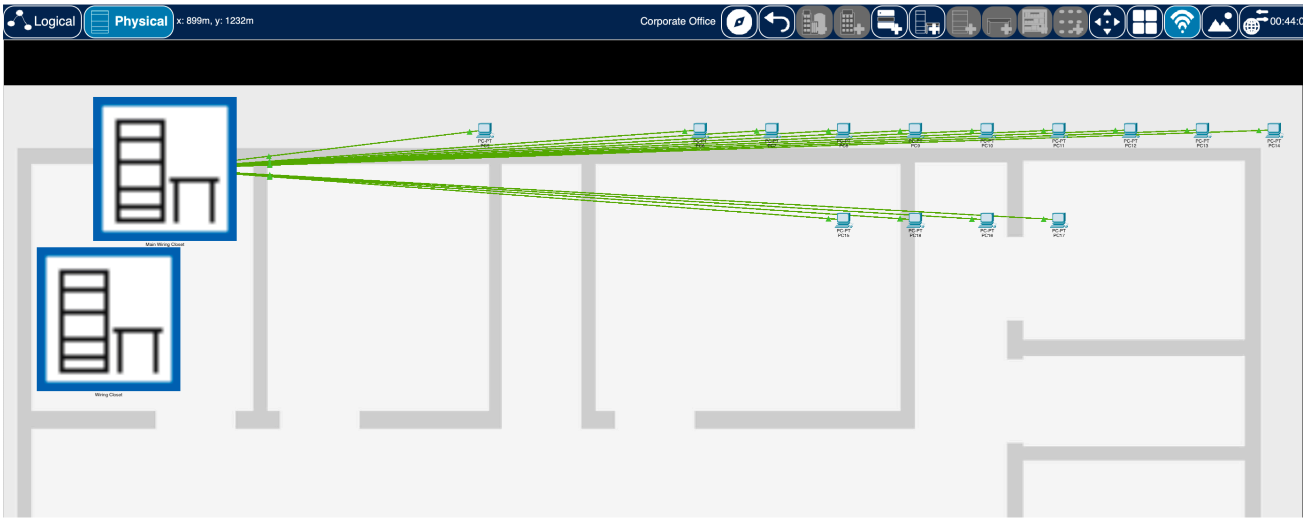
IOS Command Line Interface

```
!
!
!
!
!
!
interface FastEthernet0/0
 ip address 140.170.32.1 255.255.224.0
 duplex auto
 speed auto
!
interface FastEthernet1/0
 ip address 140.170.64.1 255.255.224.0
 duplex auto
 speed auto
!
interface Serial2/0
 ip address 199.210.121.161 255.255.255.240
!
interface Serial3/0
 no ip address
 clock rate 2000000
 shutdown
!
interface FastEthernet4/0
 no ip address
 shutdown
!
interface FastEthernet5/0
 no ip address
 shutdown
!
router rip
 version 2
 network 140.170.0.0
 network 199.210.121.0
 no auto-summary
!
ip classless
!
ip flow-export version 9
!
!
!
!
!
!
 --More--
```

Command+F6 to exit CLI focus

Copy Paste

Physical:



Introduction:

There are hundreds of technologies and protocols used in telecommunications. They run the full gamut from application level to physical level. Network Design Management and Technical Perspectives is a wide review of the significant advances and systems administration conventions and how they interrelate, coordinate, relocate, substitute, and isolate usefulness. It presents principal gives that directors and specialists ought to be engaged upon while planning a broadcast communications procedure and choosing advances, and scaffolds the correspondence hole that frequently exists among chiefs and specialized staff associated with the plan and execution of organizations. For directors, this book gives exhaustive innovation outlines, contextual investigations, and devices for navigation, prerequisites examination, and innovation assessment. It gives rules, formats, agendas, and proposals for innovation determination and setup, reevaluating, fiasco recuperation, business congruity, and security. The book refers to free data so you can stay informed concerning significant turns of events. Engineers benefit from a survey of the significant advances and conventions all over the OSI convention stack and how they connect with network plan techniques. Themes include: Internet principles, conventions, and execution; client server and conveyed organizing; esteem added organizing administrations; calamity recuperation and business congruity advancements; inheritance IBM centralized computer innovations and relocation to TCP/IP; and MANs, WANs, and LANs. For engineers needing to look under the innovation covers, Network Design gives bits of knowledge into the numerical underpinnings and hypothetical reason for steering, network plan, dependability, and execution examination. This Study Covers the

Literature Review:

The following paper by Avin et al. developed a systematic framework and methodology for analyzing and designing robust demand-aware networks (DAN) (Avin et al., 2018). They showed that the communication frequency of two nodes and the path length between them in the network are related and that this relationship is dependent on the entropy of the communication matrix. The fundamental contribution of the study is a new resilient, yet sparse, network family called short rDANs, which guarantees an anticipated path length proportionate to the entropy of communication patterns.
This study introduces a new method for designing robust demand-aware networks, or rDANs, that have demonstrable performance and robustness guarantees. The researchers studied logical new criteria for evaluating the quality of a demand-optimized network topology: if the offered link lengths

are proportionate to the entropy in the traffic matrix: often communicating nodes should be closer together. The network designs discussed in this research are based on coding theory, and entropy is a well-known measure in information and coding theory. They presented a new resilient and sparse family of network topologies that ensure an entropy-proportional anticipated path length to achieve this goal. Their technique incorporates two essential ideas: (I)the continuous-discrete design proposed by Naor and Wieder (Naor & Wieder, 2007) in the algorithmic community, and (ii) the information theory notion of prefix codes. In the continuous space, the former allowed them to explicitly reason about topologies and routing methods, and a simple discretization yielded network topologies that preserved the derived guarantees. The latter enables the topology to be linked to the communication distribution's fundamental structure (as described by entropy). They also showed that the rDAN topologies created with their method have desirable features in additional dimensions. CBR, in particular, forwards greedily, that is, just depending on the destination address and the current node's neighbors. Their topologies are likewise resilient, despite the fact that they are sparse. The number of edges that must be severed in order to disconnect the network is used to measure robustness. The following is the underlying concept of their robust demand-aware network designs, abbreviated as rDAN, and its CodeBased Routing (CBR). To begin, they created a continuous network G_c in the one-dimensional cyclic space I=[0, 1]. After that, the continuous network is discretized to obtain G. The CDF of $\mathbf{p}$ = arg $\min_{ps,pd}$ (H($\mathbf{p}_s$), H($\mathbf{p}_d$) is used to put the points x on *I*. On *I*, make U_I a uniform random variable. With I = 1, 2,..., i, the i-th point x_i is given by xi = (U_I+F_{i-1} mod 1) Though adding U_I isn't necessary for their design, the ensuing unpredictability benefits them in defeating an opponent . They then ignored the modulo operator and assumed that all points x ∈ I are modulo 1. The rest of the discretization follows the same pattern as the continuous discrete method. Each node u_i ∈ V in the discrete graph G_x is connected to the p_i-length segment s_i =[xi, xi +1]. They say that u_i covers y if a point y is in s_i. If there is an edge (y, z) in the continuous graph, such that y ∈ s_i and z ∈ s_j, a pair of vertices u_i and u_j have an edge (u_i, u_j) in G_x. The edges (u_i, u_{i+1}) and (u_{n-1}, u_0) are combined to form a ring in G_x.
In conclusion, this research presented a formal metric and technique for designing durable and sparse network topologies that provide information-theoretic path length guarantees based on coding. Regarding the researchers future work. They hope to extend rDANs to additional topologies in the future, as well as tune them to specific use scenarios (e.g., datacenters).

Another research found that demand-aware network designs, such as datacenter interconnects, are optimized for worst-case performance under arbitrary traffic patterns (Avin et al., 2019). However, when considering the real workloads and traffic patterns that they service, such network designs might be far from ideal. As a result of this discovery, demand-aware datacenter interconnects were developed, which may be adjusted based on the workload. In response to these developments, this paper begins an algorithmic investigation of demand-aware networks, with a focus on the design of bounded-degree networks. The topic of developing demand-aware networks is a basic one that has applications in a wide range of distributed and networked systems. While many peer-to-peer overlay networks are currently designed to optimize worst-case performance (e.g., minimum diameter and/or degree), it's an intriguing question whether "hard instances" actually appear in real life, and whether better topologies can be designed if we have more information about the actual communication patterns these networks serve in practice. While the issue is understandable, nothing is understood about the architecture of demand-aware networks today.
The study of a basic topic, the design of demand-aware communication networks, begins with this paper. While current advancements in datacenter network architectures inspired researchers, their concept is natural and has applicability in a wide range of distributed and networked systems (e.g., peer-to-peer overlays). The fundamental contribution of this research is to demonstrate an intriguing link between the network design issue and the communication matrix's conditional entropy.

Researchers propose a lower constraint on the predicted path length of a network with maximum degree Δ, in particular. Which is proportional to the conditional entropy of D, $H_{\Delta}(X|Y)+H_{\Delta}(Y|X)H\Delta(X|Y)+H_{\Delta}(Y|X)$ where X and Y are random variables that describe the marginal distribution of the sources and destinations in the provided communication matrix, respectively, and Δ is the base of the logarithm used to calculate the entropy. While this lower bound can be as high as $\log_{\Delta}n$, it is often significantly lower for many distributions (even constant). A novel technique for transforming a low-distortion network of maximum degree Δ to a low-degree network whose maximum degree equals the average degree of the original network while maintaining an expected path length in the order of the conditional entropy is at the heart of our technical contribution.
The research of a basic network design problem began with this publication. While developing technologies for more flexible datacenter interconnects, as well as peer-to-peer overlays, spurred our work, They feel that their paradigm is highly natural and relevant outside the application area discussed in this study. The topic of constrained network design opens up a lot of possibilities for future research. While the researchers presented asymptotically optimal network design algorithms for a wide range of distributions and believe that entropy is the right measure to assess network designs, there are still a few (dense) distributions for which the search for optimal network designs remains open, possibly necessitating the exploration of alternative flavors of graph entropy.

The following paper considers Network Design Issues with Node Connectivity Constraints that Can Survive.As edge-weighted graph and two customer sets R1 and R2 are given, minimal cost subgraph that connects all customers while ensuring two-node connectivity for the R2 customers are requested. They also analyze a form of this problem in which 2-node connectivity is only required with respect to a single rootnode, as well as a prize-collecting variant of this problem.

Some real-world tasks necessitate a long-lasting survivable connection between a customer and a specific root node r V. The 0,1,2-root-connected Steiner network problem (2RSN), which is similar to the 2NCON but only requires nodewise 2-connectedness with the root r, formalizes this. vnode-disjoint pathways with r must exist for each node v R. Such a root node could be a critical connection hub or an existing infrastructure network that has to be expanded by connecting additional consumers. prize-collecting form of the latter issue are also investigated, known as the 2-root-connected prize-collectingSteiner network problem (2RPCSN). They are provided with a reward function p: R R+ in this scenario, which represents the potential income gain if node v R is added to the solution network. The overarching aim is to maximize profit, which is defined as the difference between the benefits of the solution's nodes and the entire network installation costs. This is the same as finding a subgraph N = (VN, EN) that minimizes ∑e∈EN ce − ∑v∈VN pv As a result, the connection requirements of those consumers brought into the network must be met, as is the case with the 2RSN.

The core conclusion of this study is the use of orientation features to characterize 2-node-connected graphs. Based on directed graphs, this unique graph-theoretical approach allows us to develop two classes of ILP formulations for 2RSN, 2RPCSN, and 2NCON: DCUT is based on directed cuts, whereas DFLOW is based on multi-commodity flow. It is shown that these directed models have theoretical advantages over previously used ILP techniques, On the other hand, two notions are comparable from a polyhedral standpoint. Nonetheless, the research reveals that in reality, the cut formulation is far more effective: Researchers designed a Branch-and-Cut technique for 0,1,2-SND issues based on DCUT that allows us to provably solve test cases with up to 4900 nodes.

This study, demonstrates how to use a novel graph-theoretical orientation condition for 2-node-connected graphs to derive new, provably stronger ILP formulations for diverse classes of 0,1,2-SND issues. In addition, it was proven that adopting orientation-based formulations is advantageous in practice. To that purpose, the TSND Lib was created, a database of well-known benchmark sets that allows for systematic comparisons of current and future techniques. Although the focus of this article was on the node-connectivity aspect of 0,1,2-SND issues, our Branch-and-Cut method is the first to use strong directed models to solve arbitrary 2ECON,2NCON, and 2R(PC)SN problems. As this paper's main result is a new graph-theoretical characterization of 2-node-connected graphs based on orientation features. This enables the development of two types of ILP formulations based on directed graphs: one that uses multi-commodity flow and the other that uses cut-inequalities. It is shown that these directed models have theoretical advantages over previously known ILP methods. From a polyhedral standpoint, it is also proven that the two notions are comparable. The research, on the other hand, reveals that the cut formulation is far more effective in practice. In addition, it is provided with a set of benchmark instances that might be used in future research on the subject.

Goals of Network Theorizing:

Up to this point, we have zeroed in on portraying methods of clarification in network models. In this part, we center around describing the sorts of results that these models are utilized to make sense of. As in quite a bit of sociology, there are two nonexclusive sorts of results that organization research has looked to make sense of. The first can be extensively named decision and incorporates ways of behaving, perspectives, convictions, and (on account of aggregate entertainers like organizations)internal underlying attributes. Network research on decision has frequently been outlined concerning likeness of decision, as in making sense of which sets of hubs go with comparative decisions. Hence, work in this space is frequently alluded to as the social homogeneity writing, as verified by Borgatti and Foster (2003). The second nonexclusive result is achievement, which incorporates execution and prizes, whether at the hub or entire organization level. Work in this space is known as the social capital writing. Consolidating these two nonexclusive results with the two illustrative models we have framed, we get a basic typology of organization hypothesizing. As displayed in Table 2, the upper right quadrant, virus, comprises of flow-based clarifications of (likeness of) decision, which is a very much populated fragment of the writing. The key illustration of this sort of work is dissemination or reception of advancement concentrates in which hubs are conceptualized as influencing each other to embrace their attributes. For instance, work in the hierarchical hypothesis writing sets that one explanation associations have comparative designs is dissemination (Davis 1991, DiMaggio and Powell 1983). Broadening Dimaggio and Powell (1983), we can utilize locus of office to recognize four unique kinds of dispersion. As displayed in table 3, DiMaggio and Powell examine mimetic cycles, in which the adopter effectively looks to duplicate an attribute from a hub in its current circumstance, and coercive cycles, in which the hub is constrained by a hub in its current circumstance to embrace a quality (like a specific bookkeeping framework). Likewise, we recognize two different cycles, the student interaction, in which both the self image and its current circumstance are effectively attempting to assist the inner self with getting what the modify has, and the osmotic cycle, where neither one of the gatherings is effectively growing energy to empower the exchange, yet it happens in any case (as when the self image learns another term or idea essentially by paying attention to the change). The base right quadrant of Table 2, intermingling, contains bond-based clarifications of homogeneity. Work in this space remembers research for primary equivalence(Lorrain and White 1971, Burt 1976), which sets that hubs adjust to their surroundings, and thus hubs with comparable underlying conditions will show similitudes (Erickson 1988). For instance, assume two individuals in various areas of the planet are exceptionally focal in the guidance networks around them; that is, everyone is continually looking for their recommendation. Accordingly, the two of them foster an abhorrence of the telephone, since it so frequently brings work for them. Henceforth, equality as far as centrality level prompts comparable perspectives. Work in this space can likewise be viewed as an extraordinary instance of coordination in which hubs act comparably as opposed to just in show (as in the base left quadrant), which is like the humanistic idea of Gemeinschaft (Tönnies 1912). Other work we would arrange in this quadrant incorporates the organizations as-crystals idea of Podolny (2001), alongside the experimental work of Kilduff and Krackhardt (1994) and the character based network exploration of Podolny and Baron (1997) and adjust (2009), which proposes that organization attaches give instructive insights to crowds with respect to the quality and personality of an entertainer. In the upper left quadrant of Table 2, capitalization, contains flow-based clarifications of accomplishment. The essential idea here is that social situation in an organization gives admittance to assets. Work in this space is exemplified strength of powerless ties hypothesis (Granovetter 1973), Lin's(1988) social asset hypothesis, and the data ben-efits hypothesis of underlying openings (Burt 1992). At long last, the base left quadrant of Table 2, collaboration, comprises of bond-based clarifications of accomplishment. Here, blends of hubs go about as a unit, barring others and taking advantage of divisions among them. This isexemplified by the flood of exploration on exploratory trade organizations (Bonacich 1987, Cook and Emerson1978, Markovsky et al. 1988), as well as the control ben-efits hypothesis of underlying openings (Burt 1992). For a more nitty gritty conversation of the work falling into every quad-bluster, see the audit by Borgatti and Foster (2003).

Table 3 Breakdown of Diffusion Processes by Locus of Agency

Ego (the one adopting)	Alter (the social environment)	
	Active	Passive
Active	Apprentice processes	Mimetic processes
Passive	Coercive processes	Osmotic processes

Discussion:

In terms of related works, researchers are not aware of any work on resilient network topologies that provide entropy-proportional path length guarantees. Furthermore, there is no work on continuous-discrete network designs for non-uniform distribution probabilities that the researchers are aware of.

Recent improvements in more flexible network architectures, which also use the frequently non-uniform traffic demands (Benson et al., n.d.), most notably ProjecToR, but also Helios, REACToR, Flyways, Mirror, Firefly, and others (M. Ghobadi et al., 2016), provide a practical reason for the researcher's work.

The Continuous-Discrete method (Noar & Wieder, 2022) and the SplayNet technique (Schmid et al., 2016) are the approaches that are most similar to studies mentioned in the literature review in terms of approach. The former is tailored to demand-optimized networks, and new insights are provided, such as how greedy routing may be utilized to mix forward and backward routing, offering extra flexibility. SplayNet is a networked version of the standard splay tree datastructures that focuses on binary search trees. SplayNets, on the other hand, do not give any resilience or path diversity guarantees, unlike the topologies provided in the studies reviewed.

Optimal spanning trees Spanning trees (Mehlhorn, 1975) and far more generally, linear (resp. sparse) spanners have indeed been studied intensively in the literature (Cormen et al., 2009). When fast communication from/to a single node is required, traditional shortest path techniques can be used to build an optimal spanning tree, which is a shortest-path (spanning) tree rooted at that node.

The well-known Prim and Kruskal methods may also be used to quickly compute the optimal spanning tree in terms of total link weights: a minimal spanning tree (MST). The shortest path spanning tree and the minimal spanning tree, on the other hand, neither guarantee the path length between random network nodes nor the maximum degree of a node in the tree. This is still true for spanning tree versions that strive to improve the quality of both the shortest path tree and the least spanning tree at the same time. On the other hand, Johnson et al. demonstrated that constructing an optimal spanning tree (sum of shortest paths) across all feasible pairings is NP-complete (Johnson et al., 1978).

Spanners The bounded network designs investigated in the paper are not limited to trees, and as a result, they are connected to more generic (sparse) graph spanners, which adds a new dimension to our research. Graph spanners seek to keep the original graph's distances while utilizing fewer edges: a type of "graph compression." Peleg et al.

investigate subgraph spanners for both general and particular graphs, such as chordal graphs, with the goal of minimizing distortion between all feasible pairings (Peleg & Schäffer, 1989).
However, unlike traditional spanner issues, where the goal is to minimize the worst-case distortion (rather than the average distortion) in overall node pairings, we are only interested in the local distortion. Specifically, we want to discover a decent "spanner" that maintains neighborhood locality, i.e., 1-hop neighborhoods in the demand graph. Chan et al. investigate the creation of linear spanners (not necessarily subgraphs) that provide a constant distortion on average. However, in their model, only a tiny percentage of the pairings can have significant distortion, implying that not all pairs must have continuous distortion. The one-hop neighbors in the structure of the study, in particular, might have an arbitrary distortion (Chan et al., 2006)

The studies focus on 0,1,2-SND problems with node-connectivity constraints. While edge-connectivity requirements have been extensively studied in the literature, yielding various theoretical and computational conclusions, little is known about node-connectivity requirements in general. (Mutzel, 2017)

The core outcome of the study is the use of orientation features to characterize 2-node-connected graphs. Based on directed graphs, this unique graph-theoretical approach allows us to develop two classes of ILP formulations for 2RSN, 2RPCSN, and 2NCON: DCUT is based on directed cuts, whereas DFLOW is based on multi-commodity flow. They show that these directed models have theoretical advantages over previously used ILP techniques.

It also shows, on the other hand, that the two notions are comparable from a polyhedral standpoint. Nonetheless, the research reveals that in reality, the cut formulation is far more effective: Researchers design a Branch-and-Cut technique for 0,1,2-SND issues based on DCUT that allows us to provably solve test cases with up to 4900 nodes. (Kandyba, 2017)

Although the focus of this paper is on the node-connectivity aspect of 0,1,2-SND problems, as they are the first to be able to develop a commonBranch-and-Cut framework based on directed graphs that solves the 2ECON, 2NCON, and 2R(PC)SN problems. (Chimani, 2017)

Future Recommendations :

For future work, the first study reviewed in the literature review stated that they aim to apply rDANs to additional topologies and tune them to specific use cases (e.g., datacenters). As for the second study the researchers mentioned that while their work is encouraged particularly by developing technologies for more flexible datacenter interconnects in addition to peer-to-peer overlays. The topic of constrained network design opens up a lot of possibilities for future research. While they presented asymptotically optimal network design algorithms for a wide range of distributions and believe that entropy is the right measure to assess network designs, there are still a few (dense) distributions for which the search for optimal network designs remains open, possibly necessitating the exploration of alternative flavors of graph entropy.

Conclusion:

Our main objective in this paper has been to take apart and characterize network guessing. In doing as such, we have argued that a lot of organization hypothesis (and methodology)is in view of the flow model, which is currently well elabo-appraised and effectively brings together huge parts of organization the-ory. We have additionally contended that another model, the bond model, is being worked on and might possibly unify several different areas of request. All the more by and large, we hope that our conversation of organization ideas and model-based theorizing in network exploration will help explain existing theory as well as work with the age of new hypothesis.

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