SHODH SAMAGAM

ISSN : 2581-6918 (Online), 2582-1792 (PRINT)



Various Topologies and Transmission Medias used in Computer's Local Area Networks

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ORIGINAL ARTICLE



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Received on: 15/02/2025Revised on: 16/04/2025Accepted on: 25/04/2025Overall Similarity: 09% on 17/04/2025



Plagiarism Checker X - Report Originality Assessment

> 9% Overall Similarity

Date: Apr 17, 2025 (01:32 PM) Matches: 324 / 3716 words Sources: 4

Remarks: Low similarity detected, consider making necessary changes if needed.



ABSTRACT

A computer network that connects computer and other network devices in a limited region, like in an office, or in a campus, enabling communication and resource sharing among them is called" Local Area Network or LAN". This paper gives a quick investigation into the advancement in computer LANs and their related transmission media (Stallings, 1988; Tanenbaum, 1988). It follows the history and advancement of LAN innovations from exploratory beginnings in the second part of 1960s to far reaching commercial selection in the beginning of 1990s, emphasizing the noteworthy advancements in arrange topologies and their significant affect on organize plan and execution. This paper covers different LAN topologies, specifying their physical formats, preferences, drawbacks, and affect on design and execution. In expansion to topologies, the record dives into the advancement of transmission media utilized in Local Area Networks LANs. examining their specialized details, benefits, and impediments. It shows how these communication medias have impacted speed of network, transfer speed, and helplessness to impedances. The report too contextualizes LAN headways inside worldwide innovative patterns, outlining how these advancements have driven the advanced change of different divisions, counting instruction, Government, and industry. It emphasizes the part of standardization bodies like "Institute of Electrical and Electronics Engineers" in cultivating organize interoperability and compatibility, especially through the 802 arrangement of LAN standards. This ponder

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Impact Factor SJIF (2023): 7.906

captures the energetic history of LAN advances, advertising a exhaustive understanding of their advancement, execution, and worldwide impact, marking a critical chapter in development of IT.

KEY WORDS

LAN, STAR, RING, ARPANET, IT PC, IEEE.

INTRODUCTION

This paper consider points to investigate the complexities of various LAN arrangements and communication medias, dismembering their parts within the headway of organize framework and network arrangements. The examination centers on the affect of these innovations on organize execution, adaptability, unwavering quality, and generally proficiency, giving a basic information for computer network design and its implementation techniques. Origin and developments

The advancement in technologies used in local area networks, starting from their exploratory roots during the later part of 1960s and starting of 1970s to its wide commercial and regulation appropriation through the beginning of 1990s, shows a critical chapter in computer history and its organization (Halsall, 1985; Martin, 1989). This advancement was stamped by developments in various network arrangements or topologies and their significant affect on design plan and execution. The history of LANs in India, like globally, is intertwined by PCs of personal computers and the requirements for resource sharing. Ethernet, a popular LAN technology, was invented in the 1970s, and its adoption in India followed the global trend, with initial focus on connecting computers within organizations.

The starting of LAN Innovations

LAN innovations risen from the require for proficient data sharing and asset assignment inside restricted geographic ranges, such as workplaces, campuses, or buildings (Chlamtac & Franta, 1989). The spearheading works in this thing can be followed previously to the second half of 1960s with organizations just like the "Advanced Research Projects Agency Network" (ARPANET), which though not a LAN within the conventional sense, given the basic concepts for computing in a network.

The Coming of Network Topologies

Bus Topology

The most punctual and least complex shapes of LAN had based on this topology (IEEE802.3:Ethernet Standard, 1985). Spearheaded within the decade of 70s this topology included a single cable transmission line, ordinarily twisted or coaxial cable all machines were straightforwardly associated with it.



Ring Topology

In this each computer was associated to two others, shaping a closed circle. Information in a ring arrange travelled in one course from one computer to the another. IBM's Token Ring, presented during the-

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1980s, it was a striking illustration of ring topology. It given more unsurprising arrange execution as compared to Ethernet. This was more complex and expensive to execute.



Star Topology

The star topology developed as an elective, where each hub was associated to a central hub or switch (Stallings, 1988). This plan altogether progressed arrange unwavering quality since the disappointment of a single hub did not debilitate the complete network. Star systems were less demanding to oversee and scale but required more cable and were more subordinate on the working of the central hub.



Tree Topology

The tree topology created with the help of bus and star topologies, highlighted a arrangement of starconfigured systems associated to a direct bust spine (Perlman, 1992).

Here a root node at the top and leaves at the bottom. It is used to create virtual LANs (VLANs). This topology permitted for the extension of systems and was advantageous for huge buildings or campuses



Effects on the Design and Performance of the Each Network Topology

Each network topology had an explicit impact on the performance and design of the network:

- **BUS topology** Economically effective, Its installation is easy, but there was a limit in scalability, and network collisions were applied to affect productivity.
- Ring's topology: Network performance is more predictable in this, but costly and complicated. The dependence on continuous communication reduces its reliability if the node fails.
- Star Topology: This was easy to identify high reliability and defects, but it is more expensive due to the vast cable and the dependency on the hub in the central center.
- Tree Topology: It provided the advantages of the topology of the stars and buses, and it was suitable for large -scale deployment but difficult to control.
- > Mesh Topology: It provides faster communication between nodes.

Extensive acceptance during 1980s and in 1990s

In the 1980s, LAN became an important part of the arithmetic environment in the computing environment of businesses, educational and Government agencies. The spread of HR computers and the requirements for general resources such as printers and servers have intensified this expansion. During this time, Ethernet was developed to support higher bandwidth, with standards such as IEEE 802.3 and IEEE 802.5 (specially for token rings).

Characteristic of Different Topologies

Various topologies starting from the 1950s to 1991 shows significant technological innovation and acceptance. Each has its unique attributes, shape, pros and cons, designes and use.

Bus – Topology

This is the starting and most basic forms, bus topology was outstanding in the 1970s. It is simple and uses of a single transmission line, usually a coaxial cable, in which all computers are connected using T-connectors directly.

Data transmitted from a node moves across the network which is received by the node whose address matched from it .

- Pros: Inexpensive and easy to install. It requires less cables than other topologies. It is good for small number of workstations. Optimum utilization of cable.
- Cons:. Performance issues due to network conflibit ficult to troubleshoot and maintain becomes slows as length of network increases.
- > **Typical Application:**It is flexible architecture means simple and reliable.

Ring Topology

This has popularized in the decade of 70s and 80s, using systems such as IBM's Token Ring. Data moves in one direction and is handed over starting from one node to the next node in a loop.

- > **Pros:** Predictable network performance. The chances of package collisions have been reduced.
- Cons: A single offensive point can interfere with the entire network. More complex installation and reconfiguration.
- Typical application:Useful where cost effective small network is required than high speed or more reliability.

Star Topology

In the 1980s, startpologies became popular, along with the popularity of Ethernet. Strokes act as

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repeaters of data flows.

- Pros: Highly reliable network. Failure to tie the knot will not affect others. Easy to install and manage. Access protocols are very simple. Each device requires only one link and one I/O port.
- Cons: Reliance on central hub functionality. It requires more cables than the bus or ring topology. Difficult to expand the network.
- > Typical Application: It is useful in big networks where reliability is very important.

Tree Topology

It has emerged in late 80s. This can be formed in two ways:

- A) By connecting number of bus topologies
- B) By connecting number of star topologies

Pros

It can be easily expanded. Network or subnetwork can be isolated and communication can be prioritized.

Cons

- > Its configuration is Complex. High maintenance is required.
- > If the main backbone channel breaks, then the entire section goes down.

Typical Use : Large campuses or departments where scalability and hierarchical control were necessary.

Mesh Topology

Here each device of network has a dedicated point to point link to every other device in network. This is also called completely connected network. Originated from heavy, low-throughput radio equipment to present days diverse applications. Emerged from 1980s.



- Pros: Fast communication between nodes. It has very much fault tolerance capacity. No chances of data collisions. Privacy and security is very high.
- Cons: Installation and reconfiguration is very difficult.Nekwork administrator should have extra load. Power consumption is high.

Typical application: Useful in military application and IoT implementations.

Transmission/communication Media

Time beginning from 1950s to till 1990 was transitive for local networks (LANs), particularly with regard to the communication media which are used in LANs. Three major types of communication media used during this period were twisted couple cables, fiber optic cables and coaxial cables. Everyone had

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different technical characteristics, pros and cons, affected network speeds, various bandwidth and different susceptibility to failures.

Twisted Pair Cables

Twisted pair wire or cables are useful from the 1950s. It was used in telephone systems, it becomes a popular LAN communication medium during 1980s after advent of Ethernet . (IEEE 802.2: Logical Link Control, 1985). In 1881 It was invented by Alexander Graham Bell, it has a long history in India, evolving from its use in early telephone systems to its current role in data networking and telecommunications, with various categories like Cat3, Cat5, Cat6, and Cat6A being used for different applications.



Technical Specifications

A couple of isolated copper wires that came together received these cables in two different types: shielded (STP) and unprotected (UTP).

- > Advantages: Cheaper and wide range. Easy and flexible to install.
- Disadvantages: Useful in Limited distance network only and it provides slower data transfer rates as compared to other medias..

Unprotected twisted pair cable is more affected by electromagnetic interference and crosstalk.

Network Impact

Due to their cost-effectiveness and simplicity in installation it is very useful for small and medium sized networks.simple installation, but its limitation is reduced bandwidth and higher sensitivity to failure.

Coaxial Cables

Coaxial cables, introduced in the decade of 40s, become popular in the 70s and 80s, specially with theactual Ethernet standard (Boggs, Mogul, & Kent, 1988; Spurgeon, 1991). In India's early computer networking history, coaxial cables, particularly those used in Ethernet standards like 10BASE5 and 10BASE2, played a vital role in establishing early LANs, though they were later superseded by twisted-pair cables.





- Technical Details: This gates its name because two conductors share a common axis as shown in figure and in short it is called as "coax". Our TV cable is very familiar example of co-axial cable. EMI effects are very less in this cable. It is again classified into i)Thinnet coaxial and ii)Thicknet coaxial cables.
- Pros: Provides Higher bandwidth as compared to twisted pair cables. Less affected by EMI and RFI(radio frequency interference).
- **Disadvantages:** Costlier than twisted pairs. Less flexible.Not easy to Install and maintained.
- Impact on Networks: Better utilized in Medium and large local area neworks which requires more bandwidth. More popular option for bus topologies.

Fiber-Optic Cables

This technology, started in the later part of 1970s and initial 1980s, greatly popularized due to fastest data transmission through light over glass or plastic fibers (Black, 1992). The history of fiber optic LANs in India, while influenced by global advancements, includes key initiatives like the BharatNet project and the contributions of Indian physicist Narinder Singh Kapany, considered the "father of fiber optics".



- Technical Uniqueness: This cables transmits data in the form of light pulses ,hence gives higher bandwidth and long distance transmission capacity as compared to other cables.
- Advantages: Fiber-optic cables provides Very high bandwidth, it gives gigabit transmission speeds .It is also free from EMI effects and RFI effects. Without signal amplifiers it can send data into lang distances quickly..
- Disadvantages: It is costlier than other cables. It requires specialized technical knowledge for its installation and maintenance.
- > Impact on Networks : Best to handle high data traffic, useful within and between buildings.

Now days, the selection of transmission medium for LANs had become an important decision, it effects design of network and its data transmission speed ,its scalability, and its reliability.

Technological Developments and Standardizations

Due in major part to the development of crucial standards and technological advancements, the landscape of Local Area Networks (LANs) has changed significantly since the 1950s (Comer, 1991; Hunt, 1991). The Ethernet and Token Ring technologies were the two most important innovations at this time. Furthermore, the development of the 802 series of LAN standards by standardization organizations—in particular, the Institute of Electrical and Electronics Engineers (IEEE)—played a crucial influence in determining the compatibility and functionality of network systems.

Ethernet - Its Origin and Evolution

Roots and Advancement: Ethernet, created by Xerox PARC in the early 1970s, spoken to a noteworthy breakthrough in LAN innovation. It was at first outlined and run on coaxial link used a bus arrangement, in which a single shared communication cable had used. Ethernet's history in India mirrors

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its global development, starting with its initial development in the 1970s by Xerox and later standardized by IEEE in 1983 as 802.3, with India adopting and evolving the technology for various applications.

- Technological Advances: Including the introduction of Ethernet over fiber optics and twisted pair, Ethernet went through a few cycles. More notable flexibility and versatility were made possible as a result. The early 1980s saw the standardization of Ethernet under the name IEEE 802.3, which sparked widespread adoption and interoperability (IEEE 802.3:Ethernet Standard, 1985; Tanenbaum, 1988).
- Affect on LAN Plan: Ethernet's basic and compelling plan made it the favored choice for numerous organizations. It permitted for generally simple extension and integration, adjusting well to the advancing needs of systems.

Token Ring Protocol

Made by IBM inside the early 1980s, the Token Ring tradition was another vital change in LAN developments. It utilized a ring topology, where each computer was related to two others, forming a circle. Token Ring innovation standardized as IEEE 802.5, was a prevalent LAN convention within the 1980s and 1990s, especially in corporate situations, but has since been to a great extent supplanted by Ethernet.

- Innovative Highlights: Token Ring was outlined to decrease collisions and make strides organize effectiveness in situations where a huge number of gadgets were communicating. This arrangement had standardized as IEEE 802.5 and this standardization cemented its utilize in certain commerce and organization settings.
- Impact on Network: In spite of the fact that this arrangement is costly and more complicated than Ethernet,But Token Ring arrangement advertised more unsurprising arrange execution and there is less collisions of data, creates it reasonable for systems where information keenness and arrange were basic (IEEE 802.5:Token Ring Standard, 1985).

Part of IEEE and the 802 Arrangement

- Standardization Endeavors: The IEEE played an instrumental portion inside the standardization of LAN developments through the 802 course of action. IEEE 802.3 standardized Ethernet, while IEEE 802.5 did the same for Token Ring. These measures ensured interoperability between contraptions and systems from unmistakable producers, a fundamental calculate inside the distant coming to allotment of LAN propels.
- Higher Impacts: The IEEE 802 rules included not reasonable Ethernet and Token Ring, but additionally other points of view of organizing, tallying farther LAN measures (rather like the creating 802.11) and bridging and trading measures (IEEE 802.11:

Inaccessible LAN Medium Get to Control (MAC) and Physical Layer (PHY) Judgments, 1990). These rules given a framework for the headway of LANs and energized the integration of differing orchestrate developments and topologies.

Progresses in the Field of Networking

The duration too saw headways in network administration conventions, its measures of security, and development of equipment like switches and center points, which advance refined LAN usefulness and productivity.

Nowadays, the LAN scene had been essentially formed by mechanical headways and the standardization endeavors of bodies just like the IEEE. Token Ring arrangements and the Ethernet had ended up the prevailing conventions, each serving distinctive arrange needs and situations. The IEEE's 802 arrangement of benchmarks played a vital part in guaranteeing interoperability and compatibility, driving the advancement of LANs from constrained, exclusive frameworks to the spine of advanced communication and data sharing. These advancements set the arrange for the another wave of networking innovations.

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Worldwide Affect and Appropriation

The time starting from the decade of 50s to nowadays, was checked by noteworthy headways in LAN innovations, which had a significant worldwide affect over different segments. The advancement of LANs encouraged phenomenal levels of network, asset sharing, and data trade. This change influenced divisions as differing as instruction, industry and Government, changing how they worked and communicated.

Affect on Education

Innovation in educational Classrooms and its Campuses:

Introduction of LANs in instructive educate drastically changed the teaching and learning process. Colleges and schools started coordination computer systems to supply understudies and workforce with get to to shared assets as network servers, memory ,printer etc and vitally, a developing riches of computerized data.

- Collaborative Learning and Inquire about: LANs empowered more collaborative and intuitively learning encounters. It has permitted to share of instructive materials and inquire about information over campus systems, cultivating collaboration among understudies and teachers. This organizing moreover encouraged associations to other educate, increased the possibility for scholarly investigate and collaboration
- Learning Based on Computers: The introduction of LANs increases learning through computers and evacuate instruction, breaking down geographical hindrances in instruction and Applications of Government.
- Streamlining of Operations: In sectors of Government, LANs were played vital role in streamlining its operations. They permitted for more proficient communication inside and between Government divisions, improving information sharing and inner forms.
- Open Administrations and E-Governance: Governments begun to use LANs to make strides open administrations. Governments digitized its of records, entered online things, and started e-governance, hence citizens started to associated with Government administrations electronically
- Security and Privacy: With the selection of Local Area Networks, problems of arrange security and information secrecy picked up conspicuousness in Government divisions, driving to the advancement of more secure network protocols.

Industrial and Commercial Affect

- Improved Efficiency and Collaboration: Within the commercial and industrial sectoors, LANs empowered businesses to improve efficiency. They upheld inside communications, encouraged the sharing of assets as-database, memory printers etc and permitted for more associative work situations.
- Rise of Worldwide Undertakings: LANs laid the basis for worldwide undertakings. Companies with different workplaces or manufacturing plants seem presently interface their operations through systems, driving to more coordinates and productive worldwide operations.
- Advancement in Commerce Models: The utilize of LANs impelled development in trade models. They empowered modern shapes of todays businesses such as online administrations and e- commerce, changing conventional advertise elements.

Worldwide Network and Data Exchange

- Breaking Down Topographical Obstructions: LAN advances played a vital part in breaking down geological boundaries, empowering worldwide network.
- Sharing of Information and Data: LANs encouraged the fast sharing and dispersal of information and data over diverse districts and divisions, quickening headways in different areas.

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Social Trade: These systems too contributed to social trades, as they empowered simpler communication and get to to assorted substance and points of view.

The worldwide affect of LAN advances starting from the decade of 50s to till 1991 was far-reaching, influencing for all intents and purposes each segment of society. In the field of education, they changed learning and inquire about; in Government sectors, it streamlined its operations and open administrations; in the industry, it has improved the efficiency and worldwide network. LANs not as it were changed how organizations worked but moreover laid the basis for the interconnected, computerized world where we live in nowadays. Their selection stamped the starting of a unused period in communication and data exchange.

CONCLUSION

The advancement of LAN from the decade of 50s to till 1991 speaks to a critical chapter within the history of data innovation, checked by quick progressions and worldwide affect. This duration has seen the improvement and refinement of different network topologies, the presentation of assorted transmission media, critical innovative developments, and far reaching selection over various divisions. Advancement of LAN arrangements or Topologies: The movement from bus arrangements to ring, star ,mesh and tree topologies outlines the industry's reaction to the developing request for more dependable, more versatile, and effective network plans. Each topology brought interesting focal points and challenges, forming the way systems were designed and utilized. Their advancement played a significant part in upgrading arrange execution and unwavering quality, illustrating the commitment of industry to development and enhancement. Progression in Transmission or communication Media:

As we move from twisted pair cable to coaxial cables and to fiber-optic innovation stamped a quantum jump in information transmission capabilities. This move not as it were expanded transmission capacity and decreased vulnerability to obstructions but moreover extended the potential scope and scale of systems, encouraging quicker and more secure information exchange over longer separations. Innovative Progresses and Guidelines: The improvement in Ethernet and arrangements of Token Ring conventions and the part of standardization bodies just as in IEEE for building up the 802 arrangement of LAN benchmarks were crucial. These measures guaranteed interoperability and compatibility, cultivating a more bound together and proficient approach to arrange plan and execution. Worldwide Affect and Selection: The far reaching selection of LAN innovations changed processes of works in Government, in education, also in industry. LANs had democratized get to data, streamlined communication, and presented modern levels of proficiency and collaboration. They played a basic part in breaking down topographical obstructions, clearing the route for the present day, interconnected world. Conclusively, the period from the 1950s to 1990's was a time of groundbreaking advancements in LAN advances, characterized by a fast pace of advancement and a significant worldwide affect. The headways in organize topologies, transmission media, mechanical benchmarks, and their appropriation over different segments laid the basis for the advanced period (Stallings, 1988; Tanenbaum, 1988; IEEE Guidelines Affiliation, 1985; Boggs, Magnate, & Kent, 1988; Perlman, 1992; Halsall, 1985; Martin, 1989; Chlamtac & Franta, 1989; Comer, 1991; Dark, 1992; Spurgeon, 1991; Chase, 1991).

REFERENCES

- 1. IEEE Standards Association. "IEEE 802.11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications (1990)."
- 2. IEEE Standards Association. "IEEE 802.2: Logical Link Control (1985)."
- 3. IEEE Standards Association. "IEEE 802.3: Ethernet Standard (1985)."
- 4. IEEE Standards Association. "IEEE 802.5: Token Ring Standard (1985)."
- 5. https://www.papers.ssrn.com/sol3/papers.cfm, Assessed on 02/01/2025.

April to June 2025www.shodhsamagam.comA Double-Blind, Peer-Reviewed, Referred, Quarterly, MultiDisciplinary and Bilingual International Research Journal

- 6. https://www.cbtnuggets.com/blog/technology/networking/what-is-bus-topology,Assesed on 12/01/2025.
- 7. https://www.shiksha.com/online-courses/articles/what-is-ring-topology-blogId-156219, Assessed on 12/01/2025.
- 8. https://circuitglobe.com/difference-between-star-and-ring-topology.html, Assessed on 15/01/2025.
- 9. https://www.indiamart.com/proddetail/unshielded-twisted-pair-cable-7581457991.html, Assesed on 20/01/2025.
- 10. https://www.omnisecu.com/basic-networking/different-types-of-shields-in-stp-shielded-twisted-paircable.php, Assessed on 20/01/2025.
- 11. https://www.techtarget.com/searchnetworking/definition/coaxial-cable-illustrated, Assessed on 21/01/2025.
- 12. https://www.fibersavvy.com/pages/what-is-a-fiber-optic-cable-what-are-fiber-optic-cables-fiber-savvy, Assesed on 22/01/2025.

13. https://www.tpointtech.com/what-is-mesh-topology, Assessed on 23/01/2025.