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MULTI FLOW SCHEDULING SENSOR AWARE IN UNDERWATER AQUATIC NETWORKS

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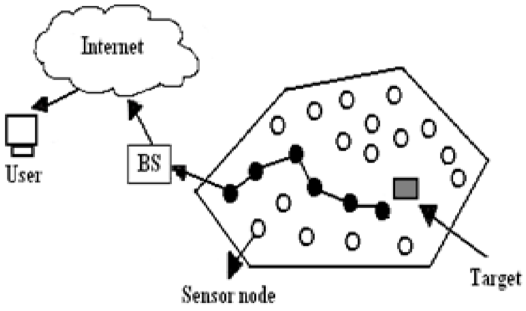
ABSTRACT-

The maximum multi-flow scheduling in an underwater acoustic sensor network. The network consists of underwater sensor nodes and surface gateways. The objective is to maximize the sum of the flows that can be finished within a fixed time duration. To address challenges posed by large sound propagation latency, we convert the original network to a time-expanded network, and develop a linear programming (LP) formulation for the maximum multi-flow scheduling. The solution to the LP formulation provides an upper bound of the maximal achievable flow. Through introducing a stronger constraint into the LP formulation, a feasible multi-flow transmission schedule is proposed, which guarantees a small approximation factor. Simulations are conducted to verify the theoretical results. Due to the battery resource constraint, it is a critical issue to save energy in wireless sensor networks, particularly in large sensor networks. One possible solution is to deploy multiple sink nodes simultaneously. In this paper, we propose a protocol called MRMS (Multipath Routing in large scale sensor networks with Multiple Sink nodes) which incorporates multiple sink nodes, a new path cost metric for improving path selection, dynamic cluster maintenance and path switching to improve energy efficiency. MRMS is shown to increase the lifetime of sensor nodes substantially compared to other algorithms based on a series of simulation experiments.

1 INTRODUCTION

Underwater acoustic sensor networks (UWSNs) have been commonly regarded as the enabling techniques for real-time and in situ data collection in a wide range of aquatic applications. The underwater nodes and gateways are acoustically connected under water, while the gateways can be also connected via high-rate radio links above water surface. A fundamental operation for UWSNs is to deliver large amount of data from underwater sensor nodes to surface gateways Relative to terrestrial radio networks, grand challenges are possessed by the large sound propagation latency in underwater acoustic networking. Recently, a series of works have been developed to take advantage of the long propagation delay of acoustic transmissions to boost the network throughput.

A wireless sensor network (WSN) consists of hundreds to thousands of low-power multifunctional sensor nodes, operating in an unattended environment, and having sensing, computation and communication capabilities. The basic components of a node are a sensor unit, an ADC (Analog to Digital Converter), a CPU (Central processing unit), a power unit and communication unit. Sensor nodes are micro-electro-mechanical systems (MEMS) that produce a measurable response to a change in some physical condition like temperature and pressure. Sensor nodes sense or measure physical data of the area to be monitored. The continual analog signal sensed by the sensors is digitized by an analog-to-digital converter and sent to controllers for further processing. Sensor nodes are of very small size, consume extremely low energy, are operated in high volumetric densities, and can be autonomous and adaptive to the environment. The spatial density of sensor nodes in the field may be as high as 20 nodes/m3.As wireless sensor nodes are typically very small electronic devices, they can only be equipped with a limited power source.



Each sensor node has a certain area of coverage for which it can reliably and accurately report the particular quantity that it is observing. Several sources of power consumption in sensors are: (a) signal sampling and conversion of physical signals to electrical ones; (b) signal conditioning, and (c) analog-to-digital conversion.

1.1 CATEGORIES OF SENSOR NODES

(i) Passive, Omni Directional Sensors: passive sensor nodes sense the environment without manipulating it by active probing. In this case, the energy is needed only to amplify their analog signals. There is no notion of "direction" in measuring the environment.
(ii) Passive, narrow-beam sensors: these sensors are passive and they are concerned about the direction when sensing the environment.
(iii) Active Sensors: these sensors actively probe the environment.
Wireless sensor systems are accumulations of reduced size and moderately modest computational hubs that measure nearby natural conditions or different parameters and forward such data to the base station for proper preparing. The fundamental unit in a sensor system is a sensor hub.

Remote sensor systems can sense the earth, correspond with neighboring hubs and can likewise perform fundamental processing's on the information being gathered. Late advancements in sensor engineering and remote correspondence have helped in the arrangement of substantial scale remote sensor systems for a mixed bag of uses including natural checking of living space, information accumulation of temperature, weight, sound ,moistness, light, vibration and so on. For such kind of uses hundreds or a large number of minimal effort sensor hubs might be conveyed over the region to be checked. In information gathering sensor organize every sensor hub should occasionally report its sensed information to the sink.

The sensor hubs are for the most part fueled by little modest batteries. Subsequently vitality utilization ought to be overseen in a proficient approach to augment the post organization system lifetime. In the event that there is long separation between the sensor and sink, transmission is not vitality proficient since the transmission force is relative to the square or fourfold of the transmission separation. Multihop directing is performed than sensor to sink immediate transmission for long separation as more vitality could be spared. Be that as it may multihop directing reason abuse of the hubs near the sink and make them use up vitality rapidly. In a remote sensor system sensor hubs has constrained vitality .So to build the lifetime of remote sensor system vitality of sensor hubs must be preserved.

Sensor hubs after sensing the information will convey it to the sink through multihoping nodes close to the sink will expend more battery force than others. Because of this these hubs will fastly empty out their battery vitality and decrease the lifetime of the system. Sink movement is an effective strategy for upgrading the lifetime of the system. Vitality mindful sink migration system is utilized here.

A relocatable sink helps in drawing out the lifetime of the system by abstaining from staying at a certain area for quite a while which may diminish the lifetime of adjacent sensor hubs. The sink movement system has two sections. The principal part is to figure out if to trigger the sink movement by figuring out if a migration condition is met or not. The second part figures out which heading sink is heading in and the movement distance for migration condition sink intermittently gather the remaining battery vitality of every sensor hub in the remote sensor system.

At that point greatest limit way steering convention is utilized to discover the most extreme limit way regarding every sensor neighbor of the sink. For every most extreme limit way greatest limit quality is found. Sink migration happens when the greatest limit quality drops beneath an edge esteem. The sink migration component

considers the remaining battery vitality of the sensor hub and afterward drives the sink to a position with a substantial amount of lingering vitality contrasted with others.
A sensor network is composed of a large number of wireless sensors, densely deployed, in the range of a phenomenon to observe, study and/or monitor. A sensor is an electronic device which generally gathers three main capabilities: the ability to measure and collect data relative to the environment surrounding it, the ability to process these collected data, and the ability to exchange it with other devices. The other devices can be sensor nodes or sinks. A sink is a particular node which collects the information resulting from the sensing nodes, process them and/or send them to a data concentration center. Generally, sensor nodes deliver their collected data to the nearest sink.

The main constraint in sensor networks is their limited energy supply. Therefore any program running on this device has to manage carefully the autonomy issue. Indeed, it has been shown that a wireless communication is one of the more expensive operations the sensor has to perform. Hence, all research efforts in this area have focused on energy-aware solutions so that the lifetime of the network is maximized. Most proposed routing approaches in sensor networks are
centered on energy minimization by looking for multi-hop links. In fact, the largely explored multi-hop approach is based on the observation that the transmission power of a wireless communication is proportional to distance squared, or even higher (in the presence of obstacles). Hence, the multi- hop routing consumes less energy than direct communication.

Although proposed routing protocols are able to dynamically adapt according to nodes energy, the nodes nearby the sink serving as last-hop relays observe rapid depletion in their energy supply. Therefore, to improve the network lifetime by reducing the total transmission power, the sink is moved towards the last-hop relays which are the most involved in packet transmitting. Such an approach has also the advantage of reducing the average delay observed by data packets.

On the other hand, in a network where not only a single but multiple sinks are present, the correct placement of the sink nodes directly affects the lifetime of such a network. Some research works dealing with the optimal multi-sink positioning problem have been proposed. However, they have not taken into account the network evolution, they only try to place, in an optimal manner, the sinks once and for all. Once the network is deployed, it remains static.

ADVANTAGES

Network setups can be done without fixed infrastructure.
Ideal for the non-reachable places such as across the sea, mountains, rural areas or deep forests.
Flexible if there is ad hoc situation when additional workstation is required.
Implementation cost is cheap.

APPLICATION

A sensor network is designed to perform a set of high-level information processing tasks such as detection, tracking, or classification. Measures of performance for these tasks are well defined, including detection of false alarms or misses, classification errors, and track quality. Applications of sensor networks are wide ranging and can vary significantly in application requirements, mode of deployment (e.g., ad hoc versus instrumented environment), sensing modality, or means of power supply (e.g. battery versus wall socket). Sample commercial and military applications include:
Environmental monitoring (e.g. traffic, habitat, security)
Industrial sensing and diagnostics (e.g. appliances, factory, supply chains)
Infrastructure protection (e.g. power grid, water distribution)
Battlefield awareness (e.g. mutitarget tracking)
Context-aware computing (e.g. intelligent home, responsive environment

Most of the energy aware routing approaches for unattended wireless sensor networks pursue multi-hop paths in order to minimize the total transmission power. Since almost in all sensor networks data are routed towards a single sink (gateway), hops close to that sink become heavily involved in packet forwarding and thus their batteries get depleted rather quickly. In addition, the interest in optimizing the transmission energy tends to increase the levels of packet relaying and thus makes queuing delay an issue, especially for real-time traffic. In this paper we investigate the potential of gateway repositioning for enhanced network performance in terms of energy, delay and throughput. We address issues related to when should the gateway be relocated, where it would be moved to and how to handle its motion without negative effect on data traffic. We present two approaches that factor in the traffic pattern for determining a new location of the gateway for optimized communication energy and timeliness, respectively. The gateway movement is carefully managed in order to avoid packet losses.

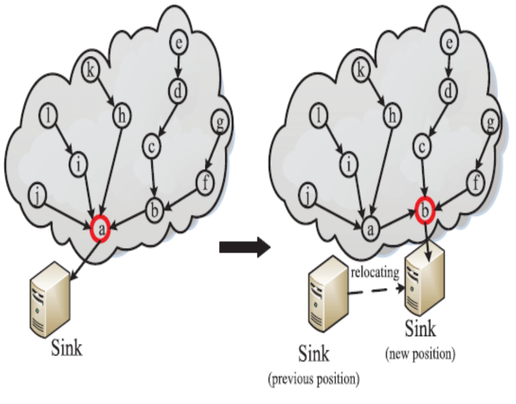
The applications of WSNs are broad, such as weather monitoring, battlefield surveillance, inventory and manufacturing processes, etc. In general, due to the sensory environments being harsh in most cases, the sensors in a WSN are not able to be recharged or replaced when their batteries drain out of power. The battery drained out nodes may cause several problems such as, incurring coverage hole and communication hole problems.

Thus, several WSN studies have engaged in designing efficient methods to conserve the battery power of sensor nodes, for example, designing duty cycle scheduling for sensor nodes to let some of them periodically enter the sleep state to conserve energy power, but not harming the operating of the sensing job of the WSN; designing energy-efficient routing algorithms to balance the consumption of the battery energy of each sensor node; or using some data aggregation methods to aggregate similar sensory data into a single datum to reduce the number of transmitted messages to extend the network lifetime of the WSN. Note that most of these approaches can coexist in the operating of the WSN.

The other energy conserving approach is to use mobile sensors to adjust their locations from a region with a high level of total battery energy of nodes to a low energy region. Although this approach can extend the network lifetime of a WSN, the relocation of sensor nodes will also expand their battery energy.

A compromise approach is to use a mobile sink to relocate its position instead of relocating the sensor nodes. As shown in the left part of Fig. 2, the sensor node *a* near the sink will quickly drain out its battery power after relaying several rounds of sensed data with reported tasks being performed by other sensor nodes, and consequently the WSN will die. We call node *a* a hotspot.

In the case of the sink being capable of moving, before the hot spot node *a* drains out all of its battery energy, the sink can move to another position to relieve the situation of heavy energy consumption of node *a*.



As in the example of the right part of Fig. 2, the sink relocates its position from the nearby node *a* to node *b*. In such a way, the role of the hot spot will be interchanged from one node to another node and consequently the network lifetime will be extended.

SINK RELOCATING SCHEME

In this paper, propose a sink relocating scheme to guide the sink when and where to move to. Some mathematical performance analyses are given to demonstrate that the proposed sink relocating scheme can prolong the network lifetime of a WSN. To investigate the performance of the EASR method against some traditional methods by numerical simulation. The organization of this paper is as follows. In the next section we will briefly describe some background related to the considered problem, which includes the energy model of a WSN, the energy efficient routing scheme that will be incorporated into the EASR scheme, and the related works of sink relocation.

Recent advance in micro-electromechanical system technology has made it possible to develop low-power and low-cost sensors with at a much reduced cost, so that large wireless sensor networks with thousands of tiny sensors are well within the realm of reality. These large sensor networks are able to support many new applications, including habitat monitoring and agricultural monitoring. In such wireless sensor networks (WSN), sensors send data packets to sink nodes through multi-hop wireless links. As the size of the network increases, the sensors near the sink nodes will dissipate energy faster than other sensors as they need to forward a larger number of messages, and prolonging the lifetime of whole network becomes a critical problem. One promising approach is to deploy multiple sink nodes in WSN, since it can decrease the energy consumption of sensors and improve the scalability of the networks.

2 LITERATURE SURVEY

2.1 G. S. Sara and D. Sridharan, “Routing in mobile wireless sensor Network: A survey”. Wireless Sensor Networks (WSNs) consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. The focus, however, has been given to the routing protocols which might differ depending on the application and network architecture. In this paper, present a survey of the state-of-the-art routing techniques in WSNs. Overall, the routing techniques are classified into three categories based on the underlying network structure: flat, hierarchical, and location-based routing. Furthermore, these protocols can be classified into multipath-based, query-based, negotiation-based, QoS-based, and coherent-based depending on the protocol operation.

Routing Protocols In Wsns.

In this section, survey the state-of-the-art routing protocols for WSNs. In general, routing in WSNs can be divided into flat-based routing, hierarchical-based routing, and location-based routing depending on the network structure. In flat-based routing, all nodes are typically assigned equal roles or functionality.

In hierarchical-based routing, however, nodes will play different roles in the network. In location-based routing, sensor nodes' positions are exploited to route data in the network. A routing protocol is considered adaptive if certain system parameters can be controlled in order to adapt to the current network conditions and available energy levels. Furthermore, these protocols can be classified into multipath-based, query-based, negotiation-based, QoS-based, or coherent-based routing techniques depending on the protocol operation.

In addition to the above, routing protocols can be classified into three categories, namely, proactive, reactive, and hybrid protocols depending on how the source finds a route to the destination. In proactive protocols, all routes are computed before they are really needed, while in reactive protocols, routes are computed on demand. Hybrid protocols use a combination of these two ideas. When sensor nodes are static, it is preferable to have table driven routing protocols rather than using reactive protocols. A significant amount of energy is used in route discovery and setup of reactive protocols. Another class of routing protocols is called the cooperative routing protocols. In cooperative routing, nodes send data to a central node where data can be aggregated and may be subject to further processing, hence reducing route cost in terms of energy use.

2.2 R. C. Shah and J. Rabaey, “Energy aware routing for low energy ad hoc sensor networks”
Wireless sensor networks (WSNs) require appropriate protocols that make judicious use of the finite energy resources of the sensor nodes. In this paper, investigate the potential energy conservation achieved by balancing the traffic throughout the WSN. We show that distributing the traffic generated by each sensor node through multiple paths instead of using a single path allows signi_cant energy savings. In order to quantitatively evaluate the benefits of the proposed load balancing technique, a new analytical model for load-balanced systems is elaborated and approved by simulations.

Conceiving energy efficient protocols

Conceiving energy-efficient protocols is a critical issue in energy-constrained wireless sensor networks. A life-optimal routing algorithm must take advantage of the total available energy resources in the network before its death. To achieve this, a load balanced routing scheme was proposed.

2.3 U. Monaco, F. Cuomo, T. Melodia, F. Ricciato, and M. Borghini, “Understanding optimal data gathering in the energy and latency domains of a wireless sensor network,”.The problem of optimal data gathering in wireless sensor networks (WSNs) is addressed by means of optimization techniques. The goal of this work is to lay the foundations to develop algorithms and techniques that minimize the data gathering latency and at the same time balance the energy consumption among the nodes, so as to maximize the network lifetime. Following an incremental-complexity approach, several mathematical programming problems are proposed with focus on different network performance metrics. First, the static routing problem is formulated for large and dense WSNs. Optimal data-gathering trees are analyzed and the effects of several sensor capabilities and constraints are discussed, e.g., radio power constraints, energy consumption model, and data aggregation functionalities. Then, dynamic re-routing and scheduling are considered. An accurate network model is proposed that captures the tradeoff between the data gathering latency and the energy consumption, by modeling the interactions among the routing, medium access control and physical layers.

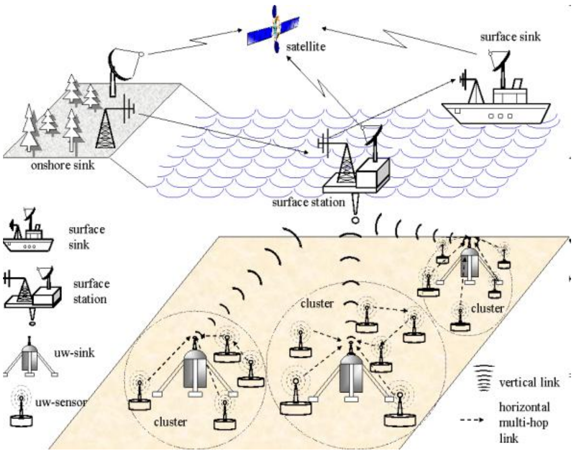
Contention-Free Mac Protocol

The objective of this paper is to provide a wide ranging analysis of the impact of different network design strategies for data gathering. To this aim, define several optimization problems in the energy-latency domain and tackle them with a multi-target approach. To design the optimization framework we considered quasi-ideal network condition by implementing a time scheduling that avoids collisions at the MAC layer and by assuming negligible transmission errors as well as ideal data correlation. The mathematical framework proposed here allows the WSN designer to foresee the impact of different design choices on optimal DA-trees as a function of different performance targets. The presented results will help researchers gain a deeper understanding of the fundamental characteristics of WSNs in the energy-latency domains.

3. RELATED WORKS

3.1. SYSTEM ARCHITECTURE

In a WSN, sensor nodes deliver sensed data back to the sink via multi hopping. The sensor nodes near the sink will generally consume more battery power than others; consequently, these nodes will quickly drain out their battery energy and shorten the network lifetime of the WSN. Sink relocation is an efficient network lifetime extension method, which avoids consuming too much battery energy for a specific group of sensor nodes. Energy-Aware Sink Relocation (EASR) for mobile sinks in WSNs. The proposed mechanism uses information related to the residual battery energy of sensor nodes to adaptively adjust the transmission range of sensor nodes and the relocating scheme for the sink. The EASR method can extend the network lifetime of the WSN significantly.



3.2 MODULES:

- Underwater Network SIM
- Acoustic Node Deployment
- LP Formulation
- Acoustic Communication As Design
- Performance Evaluation

3.2.1 Underwater Network Sim

In this module we create a UNS, It consists of a number of underwater sensor nodes, underwater sink, surface station, Autonomous Underwater Vehicles (AUVs) that are deployed to perform collaborative monitoring and resource exploration tasks over a given area.

3.2.2 Under water network SIM design

The NAUTILUS project aims at providing a robust networking infrastructure for underwater telerobotics. Many commercial modems to date provide sufficiently high data rates to reliability support point-to-point transmissions. The missing ingredient is their interconnection into a self organized autonomous network. The overall objective of NAUTILUS is to investigate such a solution, both theoretically and practically.

3.2.3 Acoustic Node Deployment

In this module group of sensor nodes arean chored to the bottom of the ocean. Underwater sensor nodes are interconnected to one or more underwater sinks (uw-sink). UW-sink is used to receive data from the ocean bottom network and send to a surface station. uw-sinks are equipped with two acoustic transceivers A vertical and a horizontal transceiver.

Although many localization protocols have been proposed for terrestrial sensor networks in recent years, the unique characteristics of the underwater acoustic communication channel, such as high and variable propagation delay and the three dimensional volume of the environment make it necessary to design and develop new localization algorithms.

In this paper, a localization algorithm called three-dimensional underwater localization (3DUL) is introduced. 3DUL achieves network wide robust 3D localization by using a distributed and iterative algorithm. Most importantly, 3DUL exploits only three surface buoys for localization initially.

The sensor nodes leverage the low speed of sound to accurately determine the inter-node distances. Performance evaluations show that 3DUL algorithm provides high accuracy in underwater localization, which does not degrade with network size.

3.2.4 LP Formulation

In this module, a feasible multi-flow schedule will be developed based on the LP formulation with a stronger constraint. We now present an algorithm to schedule the flow obtained in the stronger LP. In the time-expanded graph, we sort all the virtual edges with non-zero flows in two steps. Firstly, the edges will be sorted based on the time duration (βe − αe) in an increasing order. Secondly, the edges with an identical time duration will be sorted in a decreasing order based on the number of non-zero-flow edges in the conflict set, i.e., the cardinality of {˜e : ˜e ∈ C(˜e), f˜e (αe,˜e, βe,˜e) > 0}.

The simplex algorithm, developed by George Dantzig in 1947, solves LP problems by constructing a feasible solution at a vertex of the polytope and then walking along a path on the edges of the polytope to vertices with non-decreasing values of the objective function until an optimum is reached for sure.

Like the simplex algorithm of Dantzig, the criss-cross algorithm is a basis-exchange algorithm that pivots between bases. However, the criss-cross algorithm need not maintain feasibility, but can pivot rather from a feasible basis to an infeasible basis. The criss-cross algorithm does not have polynomial time-complexity for linear programming.

3.2.5 Acoustic Communication Design

We are developing a multi-hop acoustic network targeting communication distances of 50-500 meters. Using a simple FSK signaling scheme we anticipate sending 5kb/s over a range of 500m using a 30mW transmitter output. The primary limitation is set by spreading loss and the background noise of the ocean.

3.3 Performance Evaluation:

The proposed scheduling algorithm has also been validated via randomly generated network topologies with arbitrary signal propagation delays. The total amount of flow that can be scheduled without imposing the node fairness constraint is 3.916 with a breakdown of [fv1, fv2, fv3, fv4] =[1.5, 0, 2.083, 0.333]. The total amount of flow that can be scheduled with the node fairness constraint is 3.471 with a breakdown of fv1 = fv2 = fv3 = fv4 = 0.868.

3.4 CONCLUSION & FUTURE ENHANCEMENT

3.4.1 CONCLUSION:

Multi-flow scheduling is challenging in UWSNs due to the large sound propagation latency. This work focused on transmission scheduling from multiple underwater sensor nodes to any of the surface gateways. It was shown that the maximal value of the LP is at least the maximum achievable flow. A multi flow scheduling algorithm was also developed based on the solution to the LP formulation with a stronger constraint, which achieves a provable performance guarantee. Both theoretical results and the proposed scheduling algorithm were validated via simulations. which includes topology discovery, cluster maintenance and path switching. Since MRMS uses multiple sink nodes, cluster maintenance and path switching which can distribute the energy consumption in sensor networks more evenly, it enjoys significant improvement in key metrics compared to other approaches.

3.4.2 FUTURE ENHANCEMENTS:

To plan on exploring the effect of a lossy MAC layer on the MRMS, as well as how to construct node-disjoint multi paths for multiple sink nodes.

Multipath routing protocols improve the load balancing and quality of service in WSN and also provide reliable communication. The multipath routing technique which has demonstrated its efficiency to improve wireless sensor performance is efficiently used to find alternate paths between sources and sink.

Benefits of Multipath Routing
Here, the researcher describes how these benefits are achieved.

Reliability and fault-tolerance: The original idea behind using multipath routing approach in WSN was to provide path resilience (against node or link failures) and reliable data transmission. In the fault tolerance domain, whenever a sensor node cannot forward its data packets towards the sink, it can benefit from the availability of alternative paths to salvage its data packets from node or link failures.

Load Balancing: As traffic distribution is not equal in all links in the network, spreading the traffic along multiple routes can alleviate congestion in some links and bottlenecks.

QoS Improvement: QoS support in terms of network throughput, end-to-end latency and data delivery ratio is an important objective in designing multipath routing protocols for different types of networks.

Reduced Delay: The delay is minimized in multipath routing because backup routes are identified during route discovery.

Bandwidth Aggregation: Splitting data to the same destination into multiple streams while everyone is routed through a different path, the effective bandwidth can be aggregated.

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