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Advance Path Reservation and Scheduling for Bulk Transfers in Research Networks

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Abstract: The traffic generated by emerging applications, such as e-Science collaborative applications often require the transfer of large files with predictable performance among chosen paths. The ever increasing number of Internet-connected end-hosts calls for high performance end-to-end networks, which in turn leads to an increase in the energy consumed by the paths in the networks. To meet this need, we propose an end-to-end energy-cost model which is used to develop a complete energy-efficient framework adapted to Bulk Data Transfers over dedicated networks. This framework is also endowed with path prediction algorithms and adaptive scheduling management to optimize the energy used by the transfers. This paper includes: (i) an end-to-end energy-cost model that considers the topology and the traffic to estimate the energy consumed by path in a given network with energy-efficient components; (ii) a network model is adapted to Advance Bandwidth Reservations (ABR) for chosen path which is used for Bulk Data Transfer (BDT); and (iii) a new complete and energy-efficient BDT framework including scheduling algorithms which provide an adaptive and predictive management of the ABRs for paths.

I INTRODUCTION

The advance of communication and networking technologies, together with the computing and storage technologies, is dramatically changing the ways how scientific research is conducted. The ever increasing number of network-connected end-hosts calls for high-performance end-to-end networks. The traffic generated by emerging applications, such as e-Science collaborative applications, is particularly on the rise. These applications require transferring terabytes of data on a near-daily basis and with strict deadlines. These transfers are designated as Bulk Data Transfers.

From science to engineering to business, large-scale applications generate huge amounts of data which must be distributed over distant sites. More and more high speed dedicated links are set up to support this huge traffic and all the related remote management tasks. Research networks are examples of such types of dedicated networks using bandwidth reservation, like UltraScience Net, OSCARS (Ondemand Secure Circuits and Advance Reservation System),2 and DRAGON (Dynamic Resource Allocation via GMPLS Optical Networks).

There is a need for transporting large volume of data in e-science. In addition to the large volume, e-scientists routinely request schedulable high-bandwidth low-latency connectivity with known and knowable characteristics. Instead of relying on the public Internet, which has unpredictable service performance, national governments are sponsoring a new generation of optical networks to support e-science.

To meet the need of e-science, We have used energy-cost model to develop a new energy efficient framework adapted to Bulk Data Transfers through chosen path in networks. The first step understands how these equipments, on which these dedicated networks rely, use energy. The energy consumption of each equipment is included in a global energy-cost model that we designed and which takes into account the network's topology and the traffic passing through reserved path in the modeled network. The adopted framework enables switching unused network portions off during certain periods of time to save energy which will result an efficient data transfer through best path. This framework is also endowed with prediction algorithms to avoid useless switching off and with adaptive scheduling management to optimize the energy used by the transfers.

II RELATED WORK

Typical Bulk Data Transfer (BDT) applications include peer-to-peer protocols and Content Delivery Network facilities with media servers that require timely transfers of large amounts of data among these different servers.

To provision bandwidth for BDT, the two main problems are to allocate bandwidth in time and in space. These two issues are solved by bandwidth scheduling and path computation algorithms, respectively. Two basic provisioning modes are commonly distinguished:

(1) on-demand mode: a connection request is made when needed, and it is then accepted or denied depending on the current bandwidth availability; arriving requests are queued until their allocation;

(2) in-advance mode: a connection request is granted for future time-slots based on bandwidth-allocation schedules; arriving requests are scheduled in the future as soon as they arrive.

Many problems related to bandwidth allocation and path computation are NPcomplete. Lin *et al.* describe two basic scheduling problems: fixed path with variable bandwidth and variable path with variable bandwidth with a view to minimize the transfer end time of a given data size. They prove that both problems are NP-complete and they propose greedy heuristic algorithms to solve them.

The on-demand mode can be seen as a special case of in-advance mode. Thus, focusing on advance reservations does not restrict our scope. The idea of making advance reservations of network resources is not recent. The main issue is the unpredictability of the routing behavior. However, with the emergence of the MPLS (Multi-Protocol Label Switching) standard with traffic engineering and explicit routing features, it becomes possible to disconnect the reservation management from the network layer, thus leading to an easier inter-operability for the ABR management systems.

For advance reservation, different BDT scheduling techniques can be used: online scheduling where requests are processed as soon as they arrive or periodic batch scheduling where they are scheduled with a certain periodicity. Different time models can also be used: continuous time models and discrete models with fixed time slots (slices) during which the resource allocations are similar.

Several other issues related to ABRs have been explored: fault tolerance, rerouting strategies, load-balancing strategies, time-shift reservations, etc.

For the moment, none of the proposed solutions take into account the network’s energy consumption as a major issue which should influence the design of each algorithm related to the network’s management, from scheduling to routing.

III NOTATIONS

Advance reservations are especially useful for applications that require strong network quality-of-service (QoS) as it is the case in Content Delivery Networks, for example. The respect of the QoS requirements implies a tight coordination among the network elements. First, some basic notions should be defined.

Reservation: the user (end host) submits a data-transfer reservation which corresponds to a data volume and a deadline. These basic information requirements are the only ones required for simple data-transfer requests. These transfers are *malleable*, they are flexible enough to use any transmission rate, to have variable transmission rates over time, or to be split in several parts.

Agenda: each network equipment has two agendas per port (per outgoing link) for both ways (in and out). An agenda stores all the future reservations concerning its one-way link or path. This information is sometimes called the book-ahead interval.

IV PROPOSED SCHEME

The energy consumption *E* of an equipment depends on the power consumption *P* of the equipment which varies over time *t*. For an equipment (router, repeater, Ethernet card), the energy consumed by a transfer through chosen path is given by:

$E = E\text{boot} + E\text{work} + E\text{halt}$

where *E*boot and *E*halt can be equal to zero if booting and halting the equipment is not needed. we found that the energy *E*work consumed during the transfer includes these two costs and depends on:

· *BD*: the bandwidth used by the transfer;
· *L*: the length in time of the transfer;
· the cross traffic on this equipment: the consumption of a router, for example, should not be counted several times if several transfers are using it at the same time;
· the type of equipment.

The energy-cost model gives the energy consumption of a path in given network (topology, type of equipments, routing protocol) for a given traffic (bandwidth utilization). It is a generic model that can be used for any kind path in network and traffic.

Each port maintains its reservation status using a *time-bandwidth list* (TB list) which is formed by $(t[i], b[i])$ tuples, where $t[i]$ is a time and $b[i]$ is a bandwidth. These tuples are sorted in increasing order of $t[i]$. Thus, $b[i]$ denotes the available bandwidth of the concerned port during the time period $[t[i], t[i+1]]$. If $(t[i], b[i])$ is the last tuple, then it means that a bandwidth of $b[i]$ is available from $t[i]$ to ∞. Each $t[i]$ is called an *event* in the agenda.

A typical sequence of events for the reservation process:

(1) a user submits a reservation request (specifying at least the data volume and the required deadline)for bandwidth and path to the network-management system

(2) the advance-reservation environment launches the negotiation phase including admission control, reservation scheduling, and optimization policies;

(3) the notification is sent to the user when his request is accepted or rejected, and when it is scheduled;

(4) the reservation starts at the scheduled start time and ends at the scheduled end time, which occurs before the user-submitted deadline.

BDT with advance bandwidth reservations for a path require a transport protocol adapted to their specific network characteristics: one with high bandwidth and often low latency, and also free from congestion (not overloaded). The protocol used should be: reliable, fast (low overhead due to the protocol), able to work with a fixed bandwidth for a path (allocate a fixed bandwidth in an Ethernet card), and few ACKs, to increase efficiency (not a problem in dedicated networks). We assume that the routing protocol used is symmetric: the path used from a node A to a node B and the reversed path from the node B back to the node A are symmetric.

To achieve energy-efficiency for a path, our network-management infrastructure combines several techniques:

· putting unused network components in sleep mode;
· energy optimization of the reservation's scheduling by reservation aggregation;

· minimization of the control messages required by the infrastructure;
· usage of DTN (Disruptive Tolerant Network) to manage the infrastructure;
· network-usage prediction to avoid too-frequent on/off cycles.

Assuming that the complete energy-cost functions are available for all the network nodes, the key problem is to use this information in order to schedule the Bulk Data Transfers in an energy-efficient way. The goal of the scheduling algorithm is to aggregate as many reservations as possible to reduce the number of switching on and off, and thus save energy of chosen path. To take an energy-efficient placement decision, the scheduler should know the agenda of all the network equipments of the path. Then the reservation is scheduled at the less energy-consuming place. A *place* is a time period during which the bandwidth reservation for a path can be put without collapsing with others and without passing the deadline.

On a given network equipment, a new reservation can take place at the same time as another one already scheduled if the network equipment has not reached its full bandwidth for chosen path in the network. However, two reservations cannot overlap: the sum of their bandwidth can never exceed the bandwidth capacity of the path in the network. When the agenda is empty, the reservation is placed in the middle of the remaining period before the deadline if possible.

The receiver gateway has been chosen to schedule the reservation request because, that way, only one end-to-end message round-trip is required to grant a reservation. Indeed, the first end-to-end message aggregates all the agendas and energy-cost functions of chosen path from the sender to the receiver. An end-to-end message is sent from the BDT receiver to the BDT sender with the reservation scheduling in order to update all the agendas of the path if the reservation can be granted. The sender gateway is in charge of notifying the sender of the acceptance and scheduling of its reservation if the request has been accepted. Otherwise, the sender gateway proposes another solution to the end-user with a less restrictive deadline. If the user accepts this solution, the sender gateway sends the message to update all the agendas of the path.

V CONCLUSION

To meet the need of e-science, we have used energy-cost model to develop a new energy efficient framework adapted to Bulk Data Transfers through chosen path in networks. This paper includes: (i) an end-to-end energy-cost model that considers the topology and the traffic to estimate the energy consumed by path in a given network with energy-efficient components; the first step is understanding how these equipments, on which these dedicated networks rely, use energy. The energy consumption of each equipment in the path is included in a global energy-cost model that we designed and which takes into account the network's topology and the traffic passing through the modeled network. (ii) a network model is adapted to Advance Bandwidth Reservations (ABR) for chosen path which is used for Bulk Data Transfer (BDT); and (iii) a new complete and energy-efficient BDT framework including scheduling algorithms which provide an adaptive and predictive management of the ABRs for paths. This framework is also endowed with prediction algorithms to avoid useless switching off and with adaptive scheduling management to optimize the energy of path used by the transfers.

VI REFERENCES

[1] H.B. Newman, M.H. Ellisman, and J.A. Orcutt, "Data-Intensive e-Science Frontier Research," Comm. ACM, vol. 46, no. 11, pp. 68-77, Nov. 2003.
[2] I. Foster, C. Kesselman, C. Lee, R. Lindell, K. Nahrstedt, and A. Roy, "A Distributed Resource Management Architecture that Supports Advance Reservations and Co-Allocation," Proc. IFIP Seventh Int'l Workshop Quality of Service (IWQoS), 1999.
[3] Burchard L-O (2005) Networks with advance reservations: applications, architecture, and performance.J Netw Syst Manag 13(4):429–449

[4] Gunaratne C, Christensen K, Suen S (2006) Ethernet adaptative link rate (ALR): analysis of a buffer threshold policy. In: GLOBECOM'06, pp 1–6

[5] Guok C, Lee J, Berket K (2008) Improving the bulk data transfer experience. Int J Internet Protocol Technol 3(1):46–53

[6] L. Lewin-Eytan, J. Naor, and A. Orda, "Routing and Admission Control in Networks with Advance Reservations," Proc. Fifth Int'l Workshop Approximation Algorithms for Combinatorial Optimization (APPROX), 2002.

[7] K. Rajah, S. Ranka, and Y. Xia, "Scheduling Bulk File Transfers with Start and End Times," Computer Networks, vol. 52, no. 5, pp. 1105-1122, Apr. 2008.

[8] B.B. Chen and P.V.-B. Primet, "Scheduling Deadline-Constrained Bulk Data Transfers to Minimize Network Congestion," Proc. Seventh IEEE Int'l Symp. Cluster Computing and the Grid (CCGRID '07), May 2007.

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