KFUPM - COMPUTER ENGINEERING DEPARTMENT

COE-540 – Computer Networks

Statements For Projects

Project 1: Reinventing the Internet

The Internet we know and currently use has been designed for the major parts of it in the sixties and the seventies of the previous century. Even the newer versions such IPv6 had to remain tightly attached, and thus captive, to the old legacy Internet protocols for many of its inner workings for reason of interoperability and compatibility. In the past ten or even twenty years, the emergence of high-speed data applications and services, wireless/mobile access and applications, quality-of-service requirements, and other issues all have revealed some design flaws, or inadequacies, in the original design of the Internet. These inadequacies are generally related, but not limited, to the operation of the transport layer and the routing layer protocols. Several remedies and add-ons have been proposed to meet the new requirements and facilitate the adoption of these newly emerging applications and services.

It is required to produce survey report or paper that includes, but may not be limited to, the following points:

1. Identify and list the main inadequacies for the Internet citing the application and services giving rise to these inadequacies. Provide a brief explanation of the issue, supporting your argument by citation from the literature for each of these inadequacies. Maintain a list of these identified applications and services with pointers to the corresponding inadequacies.
2. Analyze and classify the root cause of these inadequacies to produce a table corresponding to the TCP/IP protocol stack with inadequacies listed against each (mainly the TCP and IP layers) layer. This step defines areas of improvement or "re-invention" for the TCP/IP protocol.
3. Give example technologies or add-ons to the conventional Internet to coup with the progressively and continuously expanding demands of Internet applications and services. These technologies may be classified based on the implementation area (core versus access) or based on the corresponding protocol stack layer(s). Example technologies include MPLS and GMPLS, IPv6, Mobile IP, NGN, etc.
4. For each group of inadequacies specified in step (2), list the main requirements for the considered applications and services, and suggest a mechanism to circumvent the identified shortcoming. Explain in brief the basic operation of the suggested mechanism.
5. Comment on the Internet2 project and its development. What is the influence of this project on the development of the current Internet? Explain.

The references below should serve as example studies and a starting point. The list is far from being comprehensive or representative. The work is to focus on very recent studies in light of the new advancements of services and applications for the Internet.

Expected Output: Survey (comprehensive) report/paper that includes the points outlined above.

References

[1] M. S. Blumenthal and D. D. Clark, "Rethinking the design of the Internet: The end-to-end arguments vs. the brave new world," ACM Transactions on Internet Technology, vol. 1, no. 1, August 2001, Pages 70–109.

[2] B. Dybwad. (2010, June 10), *New network design could make the Internet 100 times faster* [Online], Available: http://mashable.com/2010/06/29/internet-100x-faster/

[3] A. Ford, P. Eardley, B. van Schewick, "New design principles for the Internet," IEEE International Conference on Communications Workshops, 2009.

[4] R. Aguiar, H. Einsiedler, J. Moreno, S. Gutknecht, T. Dorflinger, "A requirements analysis for the protocol stack of the future Internet," IEEE International Conference on Communications Workshops, 2009.

[5] D. Hausheer, A. Parekh, J. Walrand, and G. Schwartz, "Towards a compelling new Internet platform," 3rd IFIP/IEEE Workshop on Management of the Future Internet, 2011, pp.1224-1227.

[6] D. Clark, et. al., Towards the future Internet architecture, Request for Comments: 1287 [Online], Available: http://svn.tools.ietf.org/html/rfc1287

[7] J. Schonwalder, et. al., "Future Internet = content + services + management," IEEE Communications Magazine, vol. 47, issue 7, 2009, pp. 27-33.

[8] S. Balasubramaniam, et. al., "Biological principles for future internet architecture design," IEEE Communications Magazine, vol. 49, issue 7, 2011, pp. 44-52.

[9] P. Stuckmann and R. Zimmermann, "European research on future Internet design," vol. 16, issue 5, IEEE Wireless Communications, 2009, pp. 14-22.

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Project 2: TCP Congestion Control Using H_∞ Methods

The H_∞ approach formulates the control problem as a mathematical optimization problem in terms of the system variables and finds the controller that achieves best performance and stabilization for the control problem [1]. Researchers have utilized this approach in solving several problems in the field of networks such as the problem of power control for wireless mobile networks and also for the TCP congestion control problem. This work focuses on the use of the H_∞ approach to find an optimal TCP congestion control policy similar to the work in [2] and [3]. It is required to produce a study that implements an optimal TCP congestion control policy based on the H_∞ method that includes the following points:

1. Brief survey of the uses of the H_∞ control method in problems related to the networking field in general.
2. Thorough survey of the use of H_∞ control method in problems related to TCP congestion control and adaptive-queue management studies.
3. Focusing of TCP congestion control, specify the main shortcomings of the original congestion control algorithm built into basic TCP implementations. Give examples and preferably simulation results showing the corresponding performance in terms of suitability for high-speed connections, fairness, etc.
4. Formulate the congestion control method as a mathematical optimization problem and utilize the H_∞ control method to solve it.
5. Obtain results and compare to the original congestion control algorithm.

For the points (3) and onwards, the project may select a paper and reproduce the original work in the paper. The project may then propose enhancements to the proposed control method and show enhanced performance relative to the original work.

The references below should serve as example studies and a starting point. The is list far from being comprehensive or representative. The work is to focus on recent studies in light of the new advancements of services and applications for the Internet.

Expected Output: Comprehensive report/paper that includes the points outlined above.

References:

[1] Simon, Dan (2006), Optimal State Estimation: Kalman, H-infinity, and Nonlinear Approaches, Wiley.

[2] Z. Jianghe and L. White, "H_∞ controller design for TCP congestion control," 2011 Australian Communications Theory Workshop (AusCTW), 2011, pp. 60 – 65.

[3] H. Yang and O. Yang, "Robust explicit congestion controller design for high bandwidth-delay product network: A H infinity approach," 2010 IEEE International Conference on Communications (ICC), 2010, pp. 1–5.

[4] J. Yuanwei , et. al., “Robust H-infinity control for uncertain time-delay TCP/AQM network system,” 47th IEEE Conference on Decision and Control (CDC 2008), 2008 , pp. 1428-1433.

[5] C. Sall, et. al., “A robust controller for the TCP congestion window,” IEEE Symposium on Computers and Communications (ISCC 2008), 2008, pp. 137-142.

[6] K. Tsumura, S. Hara, A. Nakajima, “H2Performance limitation of congestion controller for TCP/AQM network systems,” 44th IEEE Conference on Decision and Control, 2005 and 2005 European Control Conference (CDC-ECC '05), 2005, pp. 6768-6773.

[7] Y. Peng and H. Ozbay, “H∞-performance analysis of robust controllers designed for AQM,”, Proceedings of the 2003 American Control Conference, 2003,vol 3, pp. 4189-4194.