Time Synchronization in Wireless Networks

E Laxman[1] M Venu Madhav[2]
1 & 2: Asst Professor, Department of CSE, Princeton college of Engineering and Technology, Telangana, India

Abstract:

Time Synchronization in wireless networks is extremely important for basic communication, but it also provides the ability to detect movement, location, and proximity. The synchronization problem consists of four parts: send time, access time, propagation time, and receive time. Three current synchronization protocol Reference Broadcast Synchronization, Timing-sync Protocol for Sensor Networks, and Flooding Time Synchronization Protocol are presented and how they attempt solve the synchronization problem is also discussed. Security concerns as well as an industry case are also presented.

Introduction

Time synchronization in all networks either wired or wireless is important. It allows for successful communication between nodes on the network. It is, however, particularly vital for wireless networks. Synchronization in wireless nodes allows for a TDMA algorithm to be utilized over a multi-hop wireless network. Wireless time synchronization is used for many different purposes including location, proximity, energy efficiency, and mobility to name a few.

In sensor networks when the nodes are deployed, their exact location is not known so time synchronization is used to determine their location. Also time stamped messages will be transmitted among the nodes in order to determine their relative proximity to one another. Time synchronization is used to save energy; it will allow the nodes to sleep for a given time and then awaken periodically to receive a beacon signal. Many wireless nodes are battery powered, so energy efficient protocols are necessary. Lastly, having common timing between nodes will allow for the determination of the speed of a moving node.

The need for synchronization is apparent. Besides its many uses like determining location, proximity, or speed, it is also needed because hardware clocks are not perfect. There are variations in oscillators, which the clocks may drift and durations of time intervals of events will not be observed the same between nodes. The concept of time and time synchronization is needed, especially in wireless networks.

This paper covers the keynote address delivered by the Chairman of the COST Action 285 at the Symposium. It outlines the studies undertaken by the members of the Action with the objective of enhancing existing modeling and simulation tools and to develop new ones for research in emerging multiservice telecommunication networks. The paper shows how the scope of COST Action 285 has been enriched by the contributions made at the Symposium

Simulation for research and design accounts for a substantial fraction of engineering computation. With valid and credible models, simulation is often dramatically more cost-effective than are real experiments, which can be expensive, dangerous, or, in fact, impossible because a new system may not yet be available. Modeling and simulation of today's wholly distributed and autonomously managed high speed/broadband networks present major challenges for the telecommunications society – some of which were addressed during the activities of the COST Action 256 [1] which was completed in June 2001.

COST 256 had the objective of determining the need and making suggestions for the enhancement of existing tools, and for developing new ones supporting the modeling and simulation of emerging terrestrial and satellite communication networks. The Action had met its desired objectives within the known resource and time constraints. In the Final Report of the Action it was stated that there was a definite and urgent need for intensifying European R&D activities on simulation and modeling tools for research in emerging multi-service telecommunications systems, in order that Europe may become a key market player in this vital area. In light of the above, and in order to make efficient use of the synergy obtained and the momentum gained during the four years of COST 256 activities, the members unanimously expressed their support for the creation of a new COST Action with the objective of further investigating the use of the powerful modeling and simulation techniques for research, and focusing on the specific area of multi-service telecommunications systems.

More than a decade of Internet topology research

When trying to assess the large body of literature in the area of Internet topology research that has accumulated since about 1995 and has experienced enormous growth especially during the last 10+ years, the picture that emerges is at best murky. On the one hand, there are high-volume datasets of detailed network measurements that have been collected by domain experts. These datasets have been made publicly available so other researchers can use them. As a result, Internet topology research has become a prime example of a measurement-driven research effort, where third-party studies of the available datasets abound and have contributed to a general excitement about the topic area, mainly because many of the inferred connectivity structures have been reported to exhibit surprising properties (e.g., power-law relationships for inferred quantities such as node degree [49]). In turn, these surprising discoveries have led network scientists and mathematicians alike to develop new network models that are provably consistent with some of this highly-publicized empirical evidence. Partly due to their simplicity and partly due to their strong predictive power, these newly proposed network models have become very popular within the larger scientific community . For example, they have resulted in claims about the Internet that have made their way into standard textbooks on complex networks, where they are also used to support the view that a bottom-up approach dominated by domain-specific details and knowledge is largely doomed when trying to match the insight and understanding that a top-down approach centered around a general quest for "universality" promises to provide . On the other hand, there is a body of work within the networking research literature that argues essentially just the opposite and presents the necessary evidence in support of a inherently engineeringoriented approach filled with domain-specific details and knowledge. In contrast to being measurement-driven, this approach is first and foremost concerned with notions such as a network's purpose or functionality, the hard technological constraints that the different devices used to build a network's physical infrastructure have to obey, or the sources of uncertainty in a network's "environment" with respect to which the built network should be robust. As for the measurements that have been key to the top-down approach, the reliance on domain knowledge reveals the data's sub-par quality and highlights how errors of various forms occur and can add up to produce results and claims that create excitement among non-experts but quickly collapse when scrutinized or examined by domain experts. While there exist currently no textbooks that document these failures of applying detail- and domain knowledge-agnostic perspective to the Internet, there is an increasing number of papers in the published networking research literature that detail the various mis-steps and show why findings and claims that look at first glance impressive and conclusive to a science-minded reader turn out to be simply wrong or completely meaningless when examined closely by domain experts.

Themes

In writing this chapter there are a number of themes that emerge, and it is our intention to highlight them to bring out in the open the main differences between a detail-oriented engineering approach to Internet topology modeling versus an approach that has become a hallmark of network science and aims at abstracting away as many details as possible to uncover "universal" laws that govern the behavior of large-scale complex networks irrespective of the domains that specify those networks in the first place.

Theme 1: When studying highly-engineered systems such as the Internet, "details" in the form of protocols, architecture, functionality, and purpose matter.

Theme 2: When analyzing Internet measurements, examining the "hygiene" of the available measurements (i.e., an in-depth recounting of the potential pitfalls associated with producing the measurements in question) is critical.

Theme 3: When validating proposed topology models, it is necessary to treat network modeling as an exercise in reverse-engineering and not as an exercise in model-fitting.

Theme 4: When modeling highly-engineered systems such as the Internet, beware of M.L. Mencken's quote "For every complex problem there is an answer that is clear, simple, and wrong.

Level Discovery Phase

The level discovery phase is run on network deployment. First, the root node should be assigned. If one node was equipped with a GPS receiver, then that could be the root node and all nodes on the network would be synced to the world time. If not, then any node can be the root node and other nodes can periodically take over the functionality of the root node to share the responsibility.

Once the root node is determined, it will initiate the level discovery. The root, level zero, node will send out the *level_discovery* packet to its neighboring nodes. Included in the *level_discovery* packet is the identity and level of the sending node. The neighbors of the root node will then assign themselves as level one. They will in turn send out the *level_discovery* packet to their neighboring nodes. This process will continue until all nodes have received the *level_discovery* packet and are assign a level.

Once again all nodes are assigned a level to create a tree type topology. The root node is level zero continuing down the tree with level one and so on. All nodes of level *i* will broadcast the *level_discovery* with all nodes of level *i-1*. This is maintained until all nodes are assigned a level.

3.2 Synchronization Phase

The basic concept of the synchronization phase is two-way communications between two nodes. As mentioned before this is a sender to receiver communication. Similar to the level discovery phase, the synchronization phase begins at the root node and propagates through the network.

Between 1990 and 2000, Internet topology research underwent a drastic change from being a data-starved discipline to becoming a prime example of a largely measurement-driven research activity. As described earlier, even though the development of abstract, yet informed, models for network topology evaluation and generation has always been a give and take between theoreticians and empiricists, for router topology modeling, the essential role that measurements have started to play came into full focus in a sequence of three seminal papers that appeared between 1998-2000.

4. CONCLUSION

In this paper we focused on the interest of soft thresholding DWT for enhancement and genetic algorithms for image segmentation. We showed that this kind of approach can be applied either for grey-level magnetic resonance images. The developed method uses the ability of GA to solve optimization problems with a large search space (label of each pixel of an image). The developed method can also integrate some a prior knowledge (such as a local ground truth) if it is available. The developed method achieved SNR value from 20 to 44 and segmentation accuracy from 82 percent to 97 percent of detected tumor pixels based on ground truth.

References

1. Chang-Tsun Li and Randy Chiao (2003), 'Multiresolution genetic clustering algorithm for texture segmentation', Image and Vision Computing, Vol. 21, pp. 955 - 966.
2. Kim E.Y., Park S.H. and Kim H.J. (2000), 'A genetic algorithm-based segmentation of Markov random field modeled images', Signal Processing Letters, IEEE, Digital Object Identifier10.1109/ 97.873564. Vol. 7, No. 11, pp. 301- 315.
3. Minglun Gong and Yee-Hong Yang (2001), 'Genetic-based multiresolution color image segmentation', Vision Interface, pp. 141–148.
4. Nordin P. and Banzhaf W. (1996), 'Programmatic compression of images and sound', In Genetic Programming 1996,Proceedings of the First Annual Conference, Koza J. R. Editors, MIT Press, pp. 345-350.
5 Ou Y., Cheng W. and Han Ferng-ching (2004), 'Based on genetic algorithm fuzzy c-means clustering algorithm', Journal of Chongqing University, Vol. 27 No. 6, pp. 89 - 92.
6 . Philippe Andrey (1999), 'Genetic algorithms applied to image segmentation' Image and Vision Computing, Vol. 17, pp.175- 187.