

Mobile Ad Hoc Networking and the IETF

Joseph P. Macker^a

macker@itd.nrl.navy.mil

M. Scott Corson^b

corson@isr.umd.edu

^a Information Technology Division, Naval Research Laboratory, Washington, DC, USA

^b Institute for Systems Research, University of Maryland, College Park, MD, USA

This article is part of a series of articles providing a snapshot of work underway within the Mobile Ad Hoc Networking (manet) Working Group of the Internet Engineering Task Force (IETF). The article summarizes manet meeting activities at the 45th IETF conference in Oslo, Norway. It also presents some current issues and activities being promoted within the group.

The mobile ad hoc networking (manet) WG held one meeting in Oslo on Wednesday, July 14. The session was chaired by Joe Macker and began with a short introduction and session agenda review. The meeting agenda was roughly organized into two parts. First, recent or “anticipated” protocol updates were scheduled for review by the corresponding authors. Second, additional manet architecture and issues presentations were scheduled. These additional presentations touched on topics such as: mobile IP and manet integration, manet protocol energy consumption, and proposals for hierarchical manet architectures.

Existing Manet Protocol Review and Status

The first presentations were from the Carnegie Mellon University (CMU) Monarch team: Dave Johnson, Josh Broch, and Dave Maltz. An updated version of the Dynamic Source Routing [1] (DSR) Internet Draft (I-D) has been recently provided within the manet WG. Josh Broch began by presenting a review of the present DSR manet addressing approach. In the DSR addressing approach, a single IP address is used per node with multiple interface indexes to identify multiple interfaces. At present, a single network address space is used for all nodes in a single manet, and the potential for increasing scalability through the use of multiple manet substructures was discussed. The chair recommended consideration for future support of subnet masking in DSR route collection. The DSR authors appeared to agree that this extension was desirable and indicated it would be accommodated in a future revision. Next, Dave Maltz discussed ongoing work by CMU in providing openly available manet-related tools within the Berkeley ns2 simulation environment. This talk focused on a manet emulation capability that allows interaction of manet simulation models with live, implemented systems. This emulation capability is an exciting prospect for manet designers and developers, and will allow for easier and more comprehensive testing in the future. This emulation work leverages off initial ns2 emulation work done by Kevin Fall under the VINT project. Initial performance validation results comparing the simulation and emulation results for the existing models. The ability to introduce and evaluate real hardware and applications within the emulation environment was discussed as an additional benefit. New CMU software ports to ns2 were anticipated to be available in about 2 months.

Jiang Mingliang, of the National University of Singapore, followed the CMU presentations by discussing an update of recent Cluster Based Routing Protocol (CBRP) [4] modifications and evaluation results. First, a number of protocol mod-

ifications were discussed. A new local repair mechanism has been added to CBRP to improve the packet delivery ratios. A simulation of CBRP has been developed based upon existing CMU ns2 manet simulation extensions. Results showed that the CBRP improved the packet delivery ratio relative to DSR for large networks (e.g., 150-200 nodes). It was claimed that CBRP would be a good choice for scaled manet scenarios. It does not seem surprising that applying a hierarchical approach will likely improve scalability under certain scenarios. At present, these initial CBRP results need further review and interpretation by other manet participants. It is hopeful that the CBRP models will be made publicly available to the manet group for additional study and evaluation.

Charlie Perkins, from Sun Microsystems, provided an update and overview of ongoing Ad Hoc On-Demand Distance Vector [2] (AODV) work. An updated I-D has been provided which covers improvements to the protocol with contributions from Elizabeth Royer and Samir Das. Extensions discussed included the following: service location functionality, an expanding ring search algorithm, and multicast algorithm changes. Service location extensions to AODV were discussed and were based upon RREP/RREQ indexed by protocol and port number. A long-lived association between the service and the IP address was assumed here. In addition, as an alternative to the “1-hop then infinity” searching approach presently used, a higher fidelity expanding ring search capability has been added. Questions remain regarding the best expanding ring search algorithm to use and more work is needed here. Also, a multicast modification has been added to AODV regarding the process of merging disjoint trees. Other changes are in the I-D as well, including a broadcast algorithm improvement and additional flags to improve the formation of trees. There was a WG comment questioning the rationale of doing service location in AODV vice using the Service Location Protocol (SLP). The group seemed to agree that there was general interest in mobile location protocols applied to manet and that other areas may also be of interest (e.g., anycasting) and that further discussion is needed.

Amir Qayyam, from INRIA, provided an update to the OLSR protocol and discussed some initial evaluation results. A power saving modification was discussed which allows OLSR nodes to go into sleep mode. Initial simulation efforts of OLSR and a skeleton model of DSR were described. This simulation used an internal INRIA simulation environment to take advantage of HIPERLAN MAC layer models. A modified IMEP was developed to combine BEACON and HELLO into a single HELLO message. This was claimed to have reduced overhead within the simulations. There was no mobility in the initial simulation runs presented. A group comment

questioned the present value of the results due to this lack of mobility. It was explained that these were preliminary results and that more detailed simulations would follow and that the initial framework had been developed.

Additional Manet Topics and Proposals

Laura Feeney, from the Swedish Institute of Computer Science, began the second part of the Manet meeting by provided a presentation of power consumption behaviors of manet protocols. First, modeled assumptions and issues were reviewed. The modeled energy cost at both sending and receiving nodes was discussed. Laura then provided a quick overview of the consumption models developed and also discussed the relationship to empirical studies done on actual hardware by others. Laura described that minor modifications were made to the ns2 extensions and simulation results were collected. Due to a lack of time, not all results could be presented in detail and it was recommended that results be provided electronically for further WG perusal and discussion.

Jari Malinen, from the Helsinki University of Technology (HUT), provided a presentation of related ongoing manet work. They are presently working on constructing a combination of manet and mobile IP approaches for an envisioned mobile architecture. A Linux-based system implementation is being developed for evaluation. HUT is considered an approach similar to the AODV service location extensions described earlier. A number of WG manet implementers commented that they also have mobile IP and manet routing protocols working together. More group discussion is needed here to determine if there are any unique requirements and/or solutions requiring further documentation.

Hong Jiang, from Lucent, presented a brief discussion on a draft framework for what was termed "An Architecture for High Speed Manet". The definition included a mobile architecture consisting of "high-speed" links (OC3 point-to-point technology was mentioned), wide area coverage (100s of miles), and a large number of nodes (100s of backbone nodes and potentially 1000s of subscribers). It was claimed that mobility management and routing should be separate. There was an indicated requirement to provide QoS services and provide distributed operation and configuration. This architecture appeared to be a description of a pseudo-cellular network in which a wireless backbone of access point nodes formed a manet. End nodes were not envisioned to be routers and mobile users gained access to the mobile infrastructure through access points (themselves being manet nodes). There was group interest in applying present or new manet technology to this problem, however, a number of questions were raised. Where does the mobile routing function reside and is it envisioned to use manet technology? The answer was that the backbone nodes are envisioned to provide a self-organizing, mobile routing infrastructure and may take advantage of existing manet routing protocols or something new. Several WG members also took issue with the term "high speed" and recommended some other adjective be used to describe this application area. It was recommended that the potential future authors consider different terminology and provide more details regarding a specific protocol approach as it relates to manet specific issues [5]. For this specific environment, with the in-

attention to support QoS, it is not clear which routing protocols best match the anticipated backbone requirements. As an example, some form of improved link-state routing for wireless operation may be a good requirements match, but this area needs further refinement and exploration.

Summary

From the summary of proceedings, it is clear that a number of manet protocols and approaches are progressing forward in terms of implementation experience and refinement. The WG is beginning to gain valuable data on anticipated protocol performance issues with some protocol cross comparison. The initial WG encouragement of openly available simulation models and analyses is becoming a reality and further development of valuable software tools (e.g., manet emulation capability) is being realized. A number of generic manet-related issues were further explored at this meeting including; routing protocol power consumption analyses, manet within hierarchical architectures, manet addressing, service location functionality, and mobile IP interaction. More detailed discussion of these topics and the relationship to WG approaches is expected in the near future.

References

- [1] J. Broch, D. Johnson, D. Maltz, "The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks," draft-ietf-manet-dsr-02.txt, June 1998. (work in progress)
- [2] C. Perkins, E. Royer, S. Das, "Ad Hoc On-Demand Distance Vector (AODV) Routing," draft-ietf-manet-aodv-03.txt, June 1998. (work in progress)
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- [4] M. Jiang, J. Li, Y. C. Tay, "Cluster Based Routing Protocol(CBRP) Functional Specification," draft-ietf-manet-cbrp-spec-00.txt, August 1998, (work in progress).
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