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**Routing and Network Mobility Management
in Next Generation Satellite Networks**

Satellite networks are an attractive option to provide broadband telecommunication services to globally scattered users, due to their extensive geographic coverage, high bandwidth availability, inherent broadcast capabilities, etc. Satellites rotating in geostationary orbit (GEO) are very well suited for broadcast services, but they suffer from high free space attenuation and long delays. On the contrary non-geostationary (NGEO) systems consisting of Medium Earth Orbit (MEO) and Low Earth Orbit (LEO) satellites offer smaller latency, lower free space loss, and better re-use of available ground-space communication frequencies, hence they are more suitable for most applications (especially for those running in real-time). However, these advantages come with a price: Footprints of satellites at lower altitudes are smaller, and global coverage can be provided by higher number of satellites that are connected each other with inter-satellite links (ISL). Moreover, lower orbit satellites move with higher speeds relative to the Earth's surface, resulting in high dynamic in the network topology. Dynamics of the satellite constellation constitute major challenge in providing efficient routing and quality of service (QoS) for rapidly-growing real-time multimedia services. On the other hand, regular NGENEO satellite networks has some facilitating features like periodicity, predictability and having highly symmetric and regular topology. For efficient networking in NGENEO satellite networks, all these features should be considered.

In this thesis, we clarify features of satellite systems that differ them from their terrestrial counterparts and propose novel routing and network mobility management techniques in NGENEO satellite networks. Firstly, we make use of geometrical properties of the network topology, and propose a priority-based adaptive routing (PAR) algorithm. Next, we focus on handling the mobility of network by utilizing satellites with Earth-fixed footprints, and extend a well-known mobility handling technique called Virtual Node (VN). We propose Multi-state Virtual Network (MSVN) topology that alleviates deficiencies of VN concept. We clarify potential advantages of MSVN by developing efficient handover mechanisms and beam management techniques in MSVN-based satellite systems. Finally, we investigate efficient integration of NGENEO satellites with High Altitude Platforms (HAPs) via high-capacity free-space optical links for carrying dense and real-time multimedia traffic. Considering the mobility and resource limitations of satellites, we propose an efficient solution for the optimal link establishment problem between HAPs and satellites.

PUBLICATIONS

Journals

- 1) Ö.Korçak, F.Alagöz, "Efficient Integration of HAPs and Mobile Satellites via Free-Space Optical Links", *Computer Networks*, 2011, accepted for publication.
- 2) Ö.Korçak, F.Alagöz, "Virtual Topology Dynamics and Handover Mechanisms in Earth-fixed Satellite Systems", *Computer Networks*, vol. 53, no. 9, pp. 1497-1511, June 2009.
- 3) Alagöz, F., Ö. Korçak, and A. Jamalipour, "Exploring the Routing Strategies in Next-Generation Satellite Networks," *IEEE Wireless Communication*, vol. 14, no. 3, June 2007 (SCI).

- 4) Korçak, Ö., F. Alagöz, and A. Jamalipour, "Priority-based Adaptive Routing in N GEO Satellite Networks," *International Journal of Communication Systems*, vol. 20, no. 3, pp. 313-333, March 2007 (SCIE).
- 5) Korçak, Ö. and F. Alagöz, "Yeni Nesil Uydu Ağlarında Yol Atama," *İletişim Çağı Dergisi*, 4. Sayı, April 2006 (in Turkish).

Conferences

- 6) Korçak, Ö. and F. Alagöz, "Link-layer Handover in Earth-fixed Satellite Systems," *IEEE ICC*, Dresden, Germany, Jun. 2009.
- 7) Korçak, Ö. and F. Alagöz, "Efficient Networking in an Integrated HAP and Mobile Satellite System with Optical Links," *Sixth IFIP/IEEE International Conference on Wireless and Optical Communications Networks (WOCN)*, Cairo, Egypt, April 2009.
- 8) Korçak, Ö. and F. Alagöz, "Multi-state Virtual Network Architecture for Next Generation Satellite Networks," *IEEE GLOBECOM*, Washington D.C., Nov. 2007.
- 9) Korçak, Ö. and F. Alagöz, "Traffic Aware Beam Management in Next Generation Satellite Networks", *International Workshop on Satellite and Space Communications (IWSSC)*, Salzburg, Austria, Sept. 2007.
- 10) Korçak, Ö. and F. Alagöz, "Deflection Routing over Prioritized Intersatellite Links in LEO Satellite Networks", *2nd IEEE International Conference on Information & Communication Technologies: from Theory to Applications (ICTTA)*, Damascus, Syria, April 2006.
- 11) Korçak, Ö. and F. Alagöz, "Analysis of Priority-based Adaptive Routing in Satellite Networks," *International Workshop on Satellite and Space Communications (IWSSC)*, Siena, Italy, Sept. 2005.
- 12) Korçak, Ö. and F. Alagöz, "Priority-based Adaptive Shortest Path Routing for IP over LEO Satellite Networks," *23rd AIAA International Communications Satellite Systems Conference (ICSSC)*, Rome, Italy, Sept. 2005.
- 13) Korçak, Ö., H.G. Çalıklı, I. Kaya, and F. Alagöz, "Performance Evaluation of Adaptive and Static Routing Algorithms and Contention Resolution Techniques in LEO Satellite Constellations," *IEEE/AIAA Recent Advances in Space Technologies*, Istanbul, Turkey, June 2005.
- 14) Korçak, Ö., M. Zeren, and F. Alagöz, "A New Approach for Wavelength Assignment in Optical Burst Switching Networks," *Second IFIP/IEEE International Conference on Wireless and Optical Communications Networks (WOCN)*, Dubai, UAE, March 2005.

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