WiFi *on the move*

State of the Art roaming in WiFi technology

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Sommario

BACKGROUND INFORMATION

Cell networks achieve smooth handoff by sharing information between towers about a given mobile device. This session data is used for routing and is updated whenever a phone switches cells [Bejerano et al. 2002; Chiasserini 2002]. The IEEE 802.11 standard lacks the handoff mechanisms available in today's cell network protocols.

HANDOVER PERFORMANCES

Mishra et al. analyzed the link-level handover performance in current IEEE 802.11 hardware [Mishra et al. 2003]. Approximately 90% of a handover delay is attributable to the terminal adapter scanning for its next AP. Their experiments also illustrate that the practical handover delay can vary widely depending on the vendors used for the terminal network card and the AP. Vatn also investigated the latency effects of a wireless handover on voice traffic [Vatn 2003]. The conclusions echo those of Mishra et al. in that the handover latency can vary widely depending on the hardware vendor used. Since our approach does not require reassociation during handover, we do not suffer from these vendor-specific delays.

QUICK HANDOVER USING FAST SCANNING

Ramani and Savage recently demonstrated that a quick link-level handover is possible on IEEE 802.11 networks when the terminal monitors the signal quality of access points and uses a fast scanning mechanism to listen to all APs in range to choose the best one [Ramani and Savage 2005]. Their SyncScan system has achieved an impressive handover as low as 5 ms. The fast scanning is achieved through driver modifications of the terminal's network adapter. On the contrary, our approach uses any unmodified IEEE 802.11 standard terminal.

IP FOR FAST ROAMING

Two well-known general approaches to handover in IP networks are Cellular IP [Valk´ 1999] and Hawaii [Ramjee et al. 1999]. In Hawaii, or Handoff-Aware Wireless Access Internet Infrastructure, messages are exchanged between the old gateway and the new gateway for forwarding packets.

Cellular IP establishes routes based on the traffic from the terminal, and handover takes place when a cross-over router is reached. A comparison of these two protocols is presented in Campbell et al. [2002]. In a different approach to mobility proposed by Caceres and Padmanabhan, access points send gratuitous ARPs to their upstream routers to create the illusion that mobile terminals are always connected to the wired network [Caceres and Padmanabhan 1998]. These approaches rely on terminals initiating the handover process, and do not address the link-level handover delay present in IEEE 802.11 networks when terminals reassociate with another access point. Other approaches to handover, such as TMIP [Grilo et al. 2001; Yokota et al. 2002], and Sharma et al. [2004], improve handover latency in IEEE 802.11 networks but do not overcome these limitations. Other general approaches such as IDMP [Das et al. 2002], SMIP [Hsieh et al. 2003], and HMIP [Soliman and Bellier 2004] focus on hierarchy to reduce the global signaling load and improve scalability. Most of these approaches require software be installed in the mobile terminals. In contrast, we teach a network-side method that is independent from the type of Protocol Data Units (PDUs) exchanged with the mobile terminal and propose a novel approach to seamlessly control the handover from the infrastructure. Seshan et al. [1996] used a multicast approach in the Daedalus project to ensure timely delivery of terminal traffic during a handover in a cell-based wireless computer network available in 1996. Later, Helmy et al. showed how fast handover can be achieved in wireless networks by requiring mobile terminals to explicitly join a multicast group to which packets are multicast-tunneled through the infrastructure [Helmy et al. 2004]. Multicast during handover, referred to as simulcast, is also used during handover in S-MIP [Hsieh et al. 2003]. In at least one embodiment our approach does not require multicasting functions and supports devices of any architecture or operating system configured for standard IEEE 802.11 Infrastructure mode of operation (also known as BSS - Basic Service Set or AP mode) while they move. Even if the examples presented do refer to such a case, the method can be applied also to support devices that operate in the IEEE 802.11 standard "ad-hoc" mode. The IEEE has also been working on standardizing handover for wireless IP networks at two different levels. The 802.11r standard aims at providing fast Basic Service Set (BSS) transition by allowing terminals to use their current access point as a conduit to other access points. The 802.21 standard aims at providing handover between different network types, commonly known as media-independent or vertical handover. These approaches require modifications to the 802.11 standard, and so to the access points and to every terminal device. In our approach, no modifications to the 802.11 standard are necessary especially from a mobile terminal perspective.

MESH NETWORKS IN WIFI ROAMING

Existing experimental wireless mesh test beds that support terminal mobility include MeshCluster [Ramachandran et al. 2005] and iMesh [Navda et al.2005], both of which work with mobile terminals in infrastructure mode. Mesh-Cluster, which uses Mobile IP (MIP) [Perkins 1996] for intra-domain handover,

shows a latency of about 700 ms due to the delay incurred during access point reassociation and MIP registration. iMesh also offers handover using regular route updates or Mobile IP. Using ISO/OSI layer-2 handover triggers (no moving terminal), handover latency in iMesh takes 50–100 ms. The approach was later used in a more realistic environment for improving VoIP performance in mesh networks, with similar results [Ganguly et al. 2006]. Another mobility experiment is described by the Smesh project in [SMESH. 2010] for terminals operating only in "ad-hoc" mode.