Ad-hoc Mobility in Satellite-based Networks for Public Safety Applications

Giuliana Iapichino, Christian Bonnet
Mobile Communications Department
Eurecom
Sophia Antipolis, France
name.surname@eurecom.fr

Oscar del Rio Herrero
RF Payload System Division
European Space Agency
Noordwijk, Netherlands
name.surname@esa.int

Cedric Baudoin, Isabelle Buret
Research Department
Thales Alenia Space
Toulouse, France
name.surname@thalesaleniaspace.com

You just need to read the last news on the newspapers all around the world to understand how important is to provide Internet connectivity to disaster areas. After Haiti Earthquake, reporters on the ground have observed that the damage done to the telecommunications infrastructure is hampering coordination efforts. But in an ironic twist, it turns out that Haiti's Internet connectivity is robust precisely because its telecommunications infrastructure is so underdeveloped. Specifically, most Haitian ISPs connect to the Internet via satellite and are not dependent on the country's lone undersea fiber optic cable link, which was knocked out the during the quake. The challenge for engineers now is the proverbial *last mile* - getting local connections to satellites restored so Non-Governmental Organizations (NGOs) and UN Nations Disaster Assessment and Coordination teams can get online. But, this is not the only problem.

Public Safety Networks (PSNs) have traditionally been owned and managed by individual agencies (e.g. fire, law enforcement, and emergency medical services) as stand-alone networks at the state or local government levels. While these networks are designed to support critical voice services within their respective coverage areas, they are often not interoperable with each other nor do they support data services. Major disasters all around the world have repeatedly shown the limitation of existing Public Safety Networks (PSNs), not able to fulfill at the same time the critical requirements of mobility, access heterogeneity, security and interoperability among different agencies. Users of these networks could greatly benefit from a common IP-based "mobile ad-hoc networking" environment in which satellite and terrestrial technologies are combined together for the development of a comprehensive end-to-end communications solution for Emergency Management applications.

In the frame of the project, we have designed an integrated satellite and terrestrial architecture based on the well-known requirements of PSNs. The architecture includes as a key aspect the fact that rescue teams can use *unmodified* mobile terminals (e.g. off-the-shelf PDA, handhelds or PC) to access to the mobile ad-hoc network infrastructure deployed at the disaster site for the last mile, moving from the coverage of one mobile mesh router to another transparently and seamlessly. The mobile terminals can have several interfaces working at the same time, thus being multi-homed, adding reliability and robustness to the system architecture. The satellite network is used for providing a backhaul connection to the headquarters, as satellites are the best and more reliable platform for communications in emergency scenarios.

The system architecture is based on two main protocols: Host Identity Protocol (HIP) and Proxy Mobile IPv6 (PMIPv6). From their combination it is possible to benefit of a global and localized mobility management scheme with additional features of security, multi-homing and access heterogeneity. A real test-bed implementation has been put in place at Eurecom laboratory where the two protocols have been implemented, combined and applied to the system architecture. The experimental results conducted on the platform for multimedia traffic have proved that the handover latency in the local domain affects the communication between peers with a delay of only 200 ms in average, assessing the viability of the proposed architecture for real-time applications such as Public Safety applications, without increasing network and terminals' complexity as well as signaling overhead.