



## Scalable Architecture for Multihop Wireless ad Hoc Networks

*NASA's Jet Propulsion Laboratory, Pasadena, California*

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**These networks could readily be expanded and reconfigured.**

A scalable architecture for wireless digital data and voice communications via ad hoc networks has been proposed. Although the details of the architecture and of its implementation in hardware and software have yet to be developed, the broad outlines of the architecture are fairly clear: This architecture departs from current commercial wireless communication architectures, which are characterized by low effective bandwidth per user and are not well suited to low cost, rapid scaling in large metropolitan areas. This architecture is inspired by a vision more akin to that of more than two dozen noncommercial community wireless networking organizations established by volunteers in North America and several European countries.

One of the basic principles of this architecture is that of a hierarchy of networks, built on local community networking via shared resources (see figure), with enough flexibility to provide service on demand and to enable growth as the need arises. In the proposed architecture, at least some users' wireless communication units would serve as relay stations for other users' units, enabling any user within the range of another, participating user to gain access to the local- and wider-area networks in a multihop manner. The success of the architecture would depend heavily on the development of an energy-efficient, multihop, ad hoc network routing protocol. This would ideally be implemented in reconfigurable hardware to enable dynamic protocol "preferencing," and easy upgrades to potential future wireless protocol standards.

Power-efficient communication would take place by multihop radio at the local level and via high-speed point-to-point links (e.g., fiber, satellite) at the global level. In a typical community, the home of each user would be equipped with a rooftop radio transceiver that, together with a number of neighboring similar units, would be a member of a microcell. Each such unit would be capable of communicating with a central unit of the microcell, either directly or by relay via one of the other members. When at home, a user's telephone, personal digital assistant (PDA), laptop computer with wireless modem, or other communication device would connect with the network via the in-home wireless link and the rooftop transceiver. When out of range of the in-home wireless link, the user would connect to the network via someone else's rooftop transceiver, or portable wireless device, in a multihop fashion.

Microcells within a community are aggregated into cells by use of a local-area network (LAN) backbone of higher speed wireless and/or wired connections. Every time a microcell connects to the wireless backbone, microcells or individual users in surrounding blocks can also connect to the network. Repeating this process, a network serving a wider area would be built. At various locations, the wireless traffic would be placed on the Internet backbone.

The proposed architecture is envisioned as extending Moore's law to Internet bandwidth and thereby offering an economic benefit. Moore's law (which is not really a law but an informal prediction that closely approximates what has been observed in industry) states that the numbers of transistors per unit area in microprocessors double about every 18 months. The consequences of Moore's law include both increasing capacity of the affected equipment and lower per-unit costs. The extension of Moore's law to Internet bandwidth has been estimated to offer the potential to reduce the cost of 1 Mb/s of Internet bandwidth to only \$1 per month after ten years.

*This work was done by Payman Arabshahi, Andrew Gray, Clayton Okino, and Tsun-Yee Yan of Caltech for NASA's Jet Propulsion Laboratory. For further information, access the Technical Support Package (TSP) free online at [www.techbriefs.com/tsp](http://www.techbriefs.com/tsp) under the Electronics/Computers category. In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:*

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