



Electronics/Computers

Scalable Architecture for Multihop Wireless *ad Hoc* Networks

These networks could readily be expanded and reconfigured.

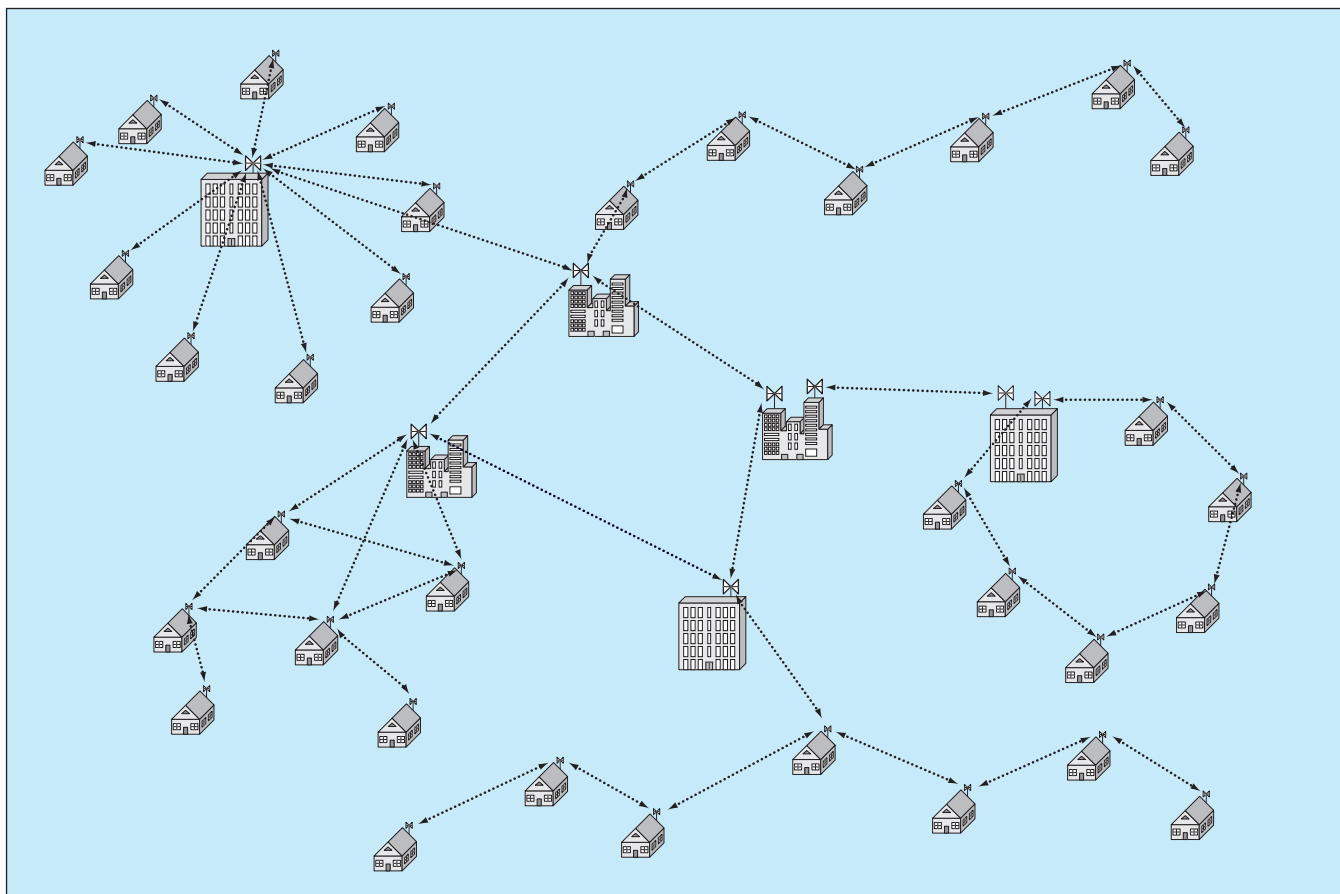
NASA's Jet Propulsion Laboratory, Pasadena, California

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 net-

works, 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



Neighboring Rooftop Radio Transceivers would be grouped into microcells connected via a wireless backbone to build city-wide and higher-level networks.

via someone else's rooftop transceiver, or portable wireless device, in a multi-hop 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. Further information is contained in a TSP (see page 1).

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Refer to NPO-30452, volume and number of this NASA Tech Briefs issue, and the page number.

Improved Thermoplastic/Iron-Particle Transformer Cores

Proper choice of particle-size distribution results in minimal eddy-current loss.

Langley Research Center, Hampton, Virginia

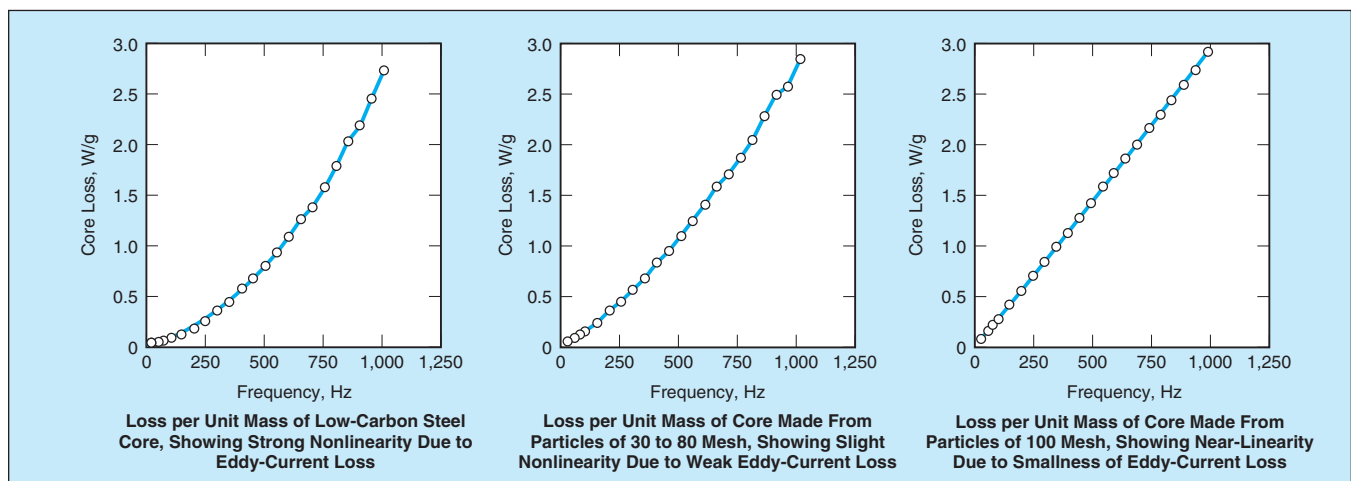
A method of fabricating improved transformer cores from composites of thermoplastic matrices and iron-particles has been invented. Relative to commercially available laminated-iron-alloy transformer cores, the cores fabricated by this method weigh less and are less expensive. Relative to prior polymer-matrix/iron-particle composite-material transformer cores, the cores fabricated by this method can be made mechanically stronger and more magnetically permeable. In addition, whereas some prior cores have exhibited significant eddy-current losses, the cores fabricated by this method exhibit very small eddy-current losses. The cores made by this

method can be expected to be attractive for use in diverse applications, including high-signal-to-noise transformers, stepping motors, and high-frequency ignition coils.

The present method is a product of an experimental study of the relationships among fabrication conditions, final densities of iron particles, and mechanical and electromagnetic properties of fabricated cores. Among the fabrication conditions investigated were molding pressures (83, 104, and 131 MPa), and molding temperatures (250, 300, and 350 °C). Each block of core material was made by uniaxial-compression molding, at the applicable pressure/temperature

combination, of a mixture of 2 weight percent of LaRCT™ (or equivalent high-temperature soluble thermoplastic adhesive) with 98 weight percent of approximately spherical iron particles having diameters in the micron range. Each molded block was cut into square-cross-section rods that were used as core specimens in mechanical and electromagnetic tests. Some of the core specimens were annealed at 900 °C and cooled slowly before testing. For comparison, a low-carbon-steel core was also tested.

The results of the tests showed that density, hardness, and rupture strength generally increased with molding pres-



The **Total Losses as Functions of Frequency** were measured in three cores at a magnetic induction of 5 kilogauss (0.5 Tesla). In general, the total frequency-dependent loss in a given core is the sum of a linear hysteresis contribution and a quadratic eddy-current contribution. Hence, the near-linearity of the curve in the 100-mesh case is evidence of low eddy-current loss.