MeshPhone: affordable mobile mesh networking for local communications

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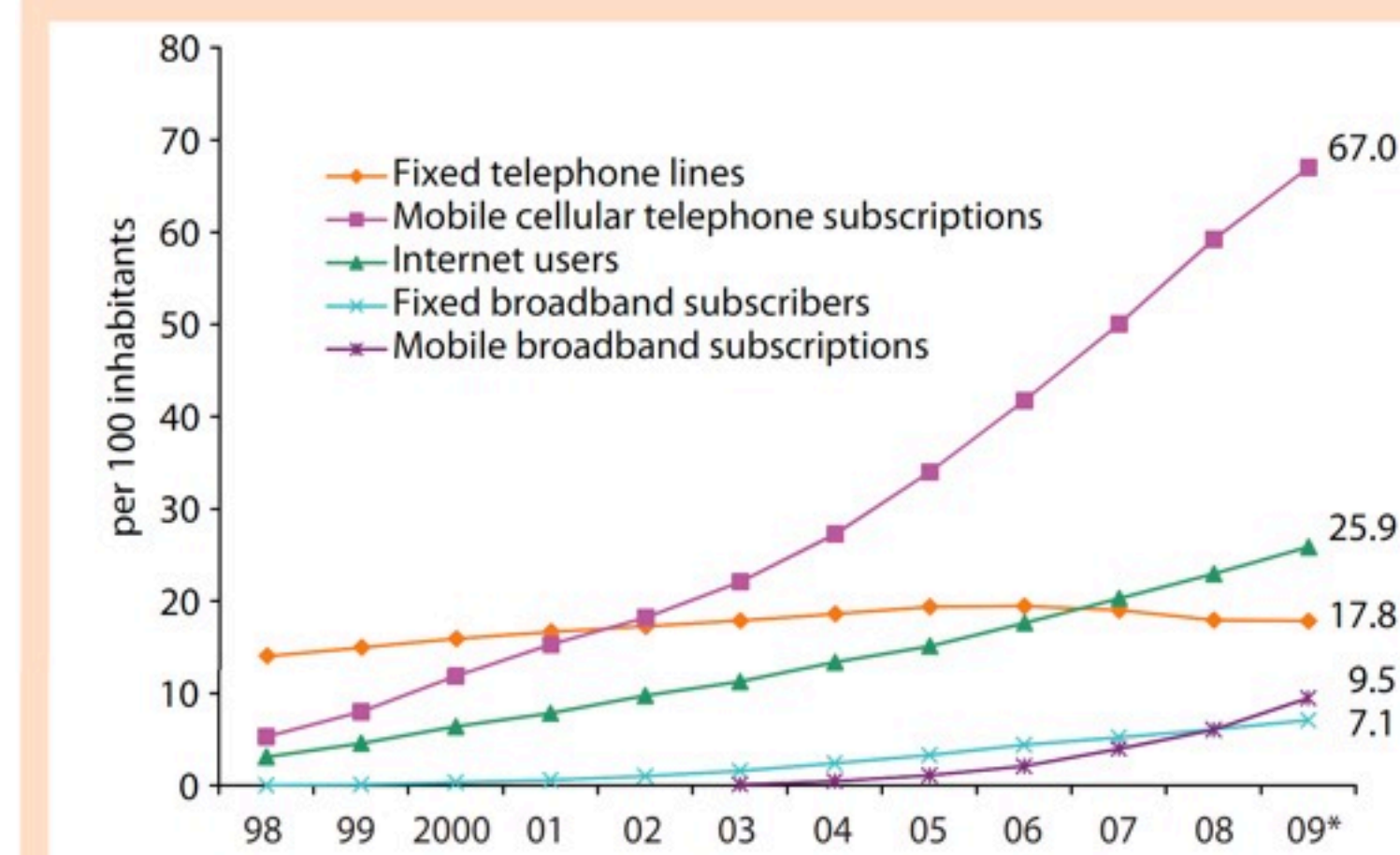
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opportunity:

The developing world has rapidly adopted cell phone technology, but still *doesn't* have **internet access** and the **communication services** it brings. (UN/ITU 2010)

Chart 1.1: Global ICT developments, 1998-2009

- Fixed telephone lines
- Mobile cellular telephone subscriptions
- Internet users
- Fixed broadband subscribers
- Mobile broadband subscriptions

67.0
25.9
17.8
9.5
7.1

Note: * Estimates.
Source: ITU World Telecommunication/ICT Indicators database.

**Chart 1.2: Mobile cellular subscriptions by level of development, 1998-2009**

- Developed
- Developing
- World

113.6
67.0
56.8
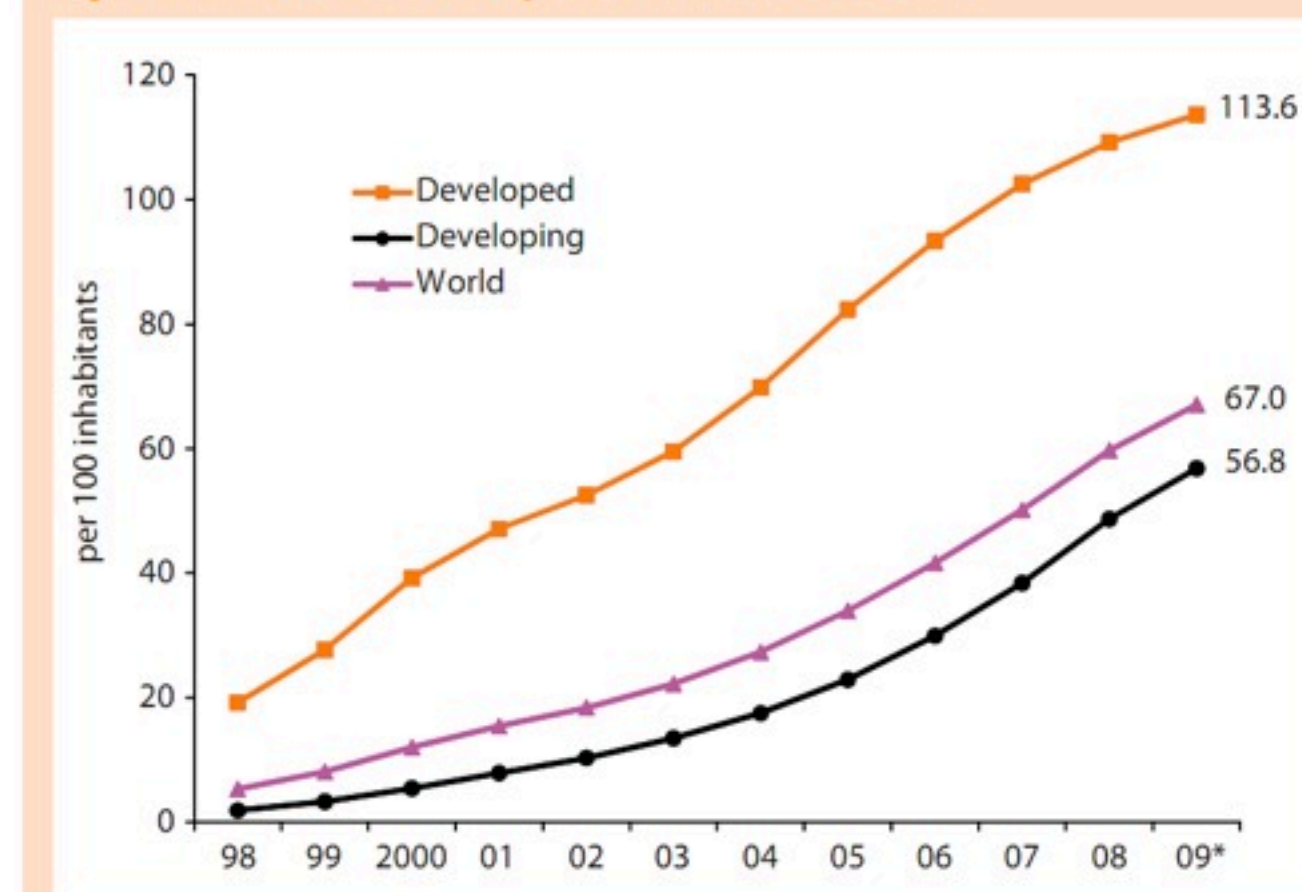
Note: * Estimates.
Source: ITU World Telecommunication/ICT Indicators database.

Chart 1.3: Internet users by level of development, 1998-2009

- Developed
- Developing
- World

64.2
25.9
17.5
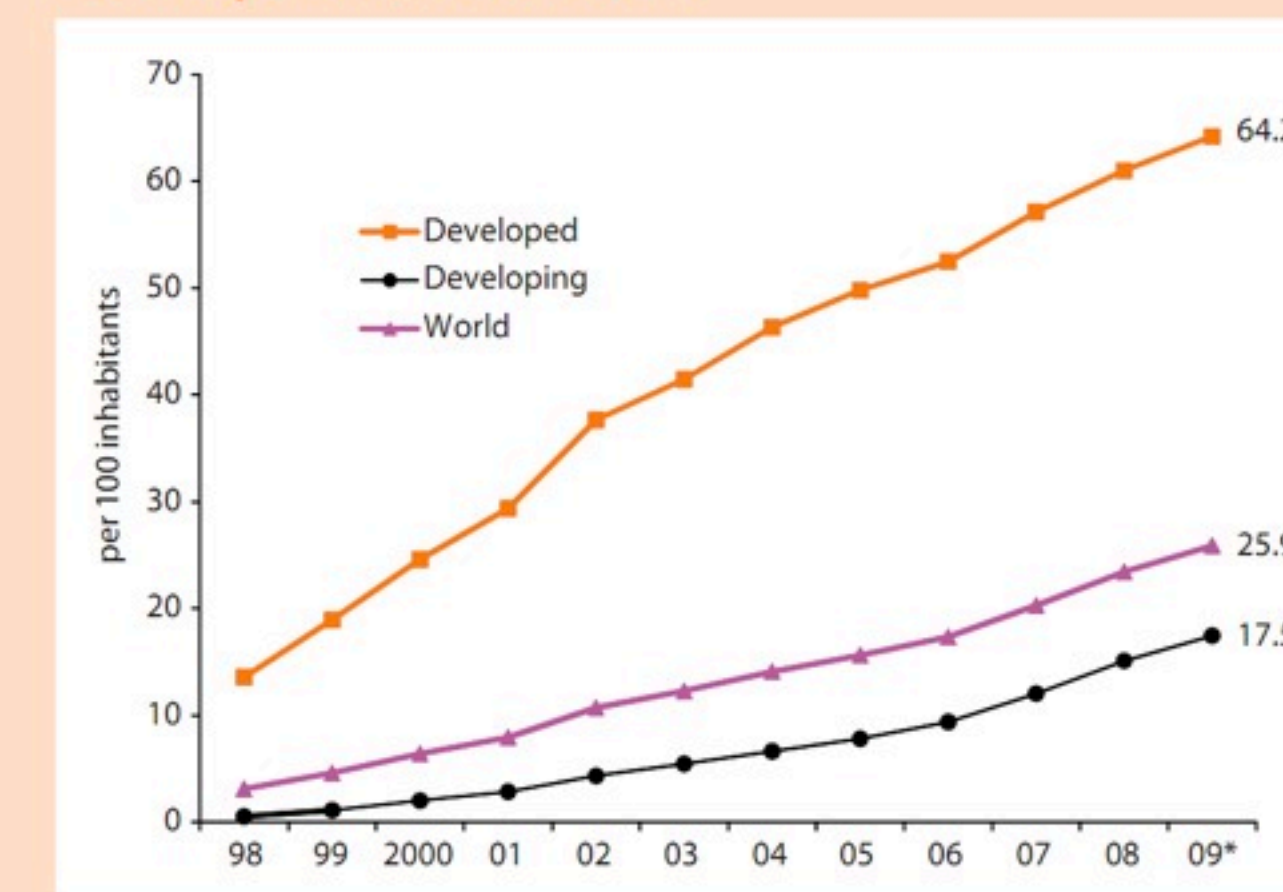
Note: * Estimates.
Source: ITU World Telecommunication/ICT Indicators database.

The vast majority of the world's population has no equivalent of Facebook, Twitter, Wikipedia, or even Craigslist. The modern communication services which form the basis for the **information economy** simply do not exist for most people.
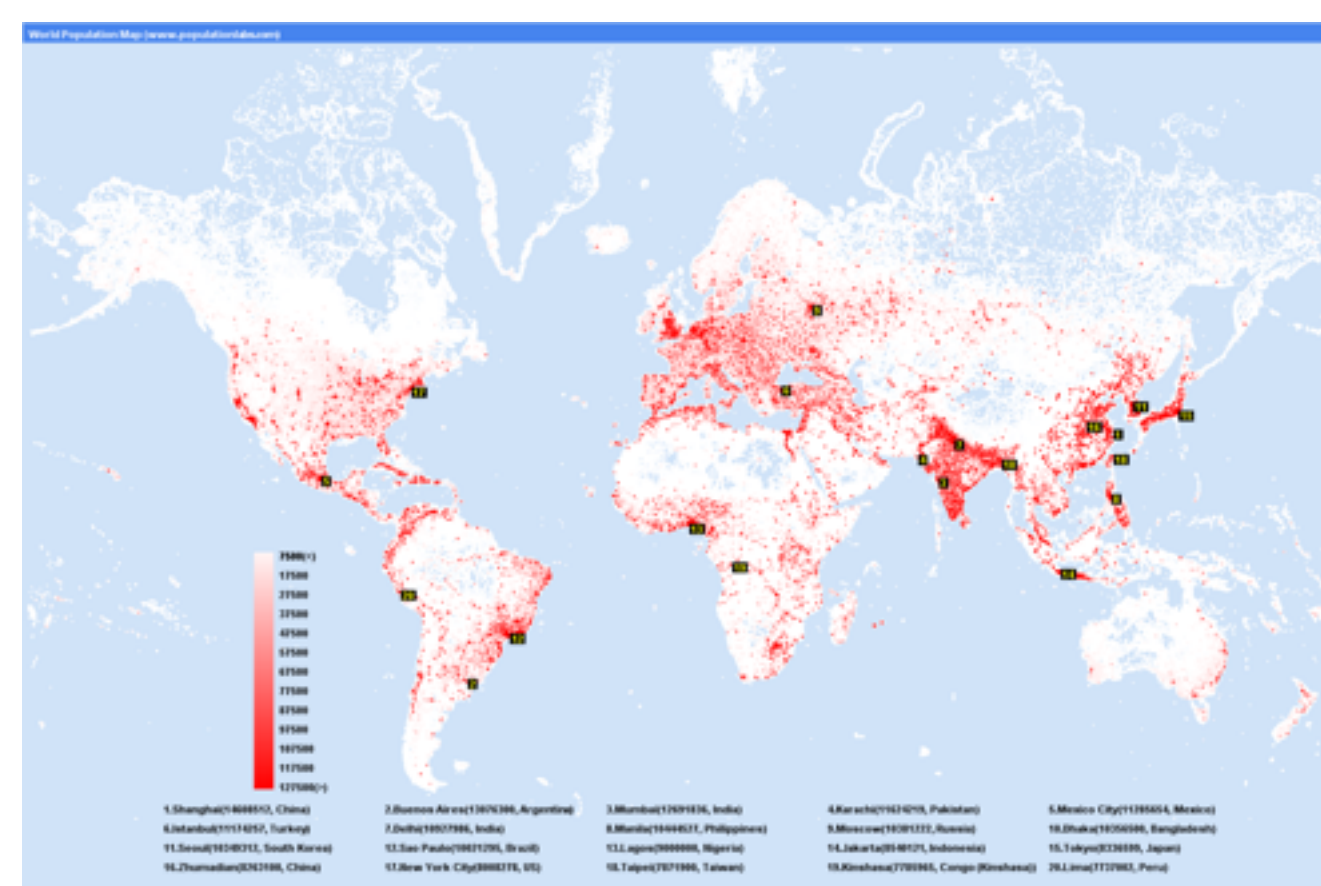
population density vs. internet connection density

Meanwhile, considerable research effort has been spent on the development of **robust** ad-hoc wireless networks, scalable **decentralized** communications protocols, and **low-cost** power-efficient microcontrollers and digital radios.
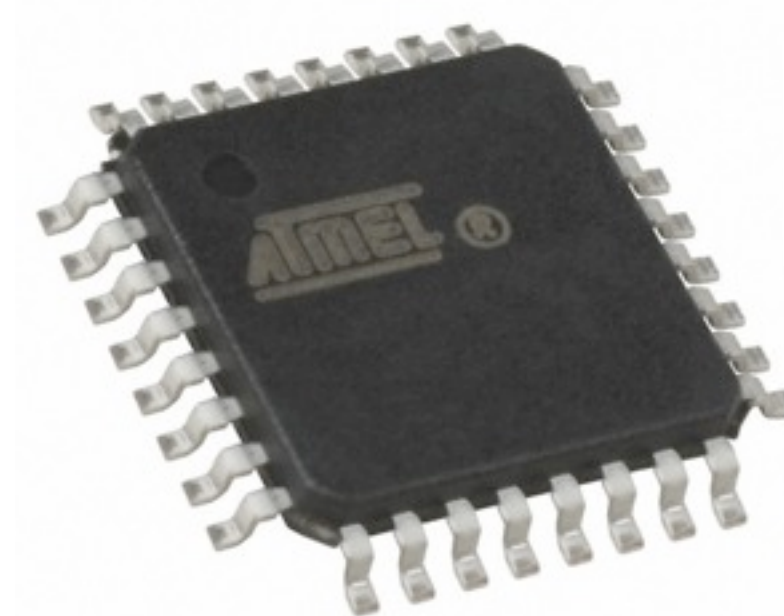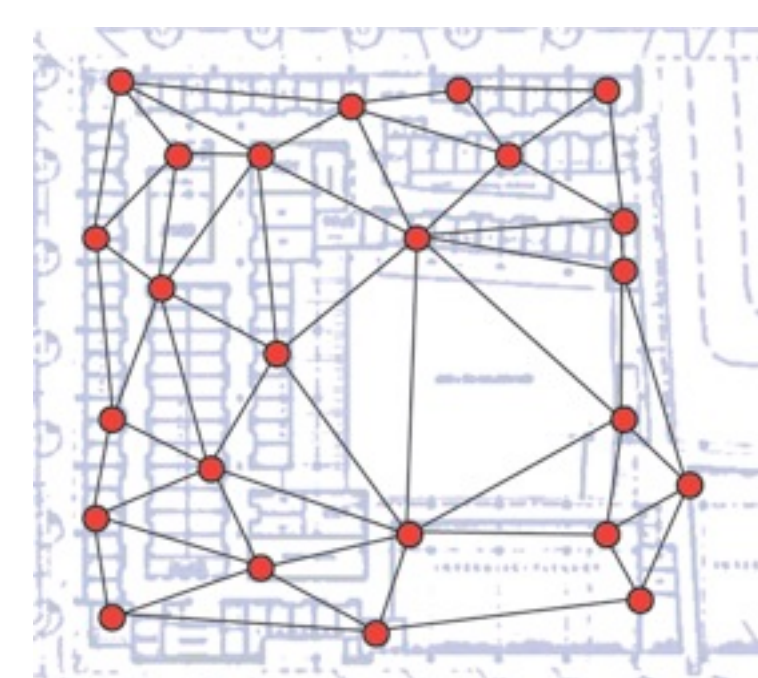

We can make digital communications services affordable by **everyone** on earth!

innovation:

$$\left(\quad \cdot \quad \cdot \quad \right)^n$$

We are developing an **open**-source, **standards**-compliant and **infrastructure**-free **mobile personal communications device** capable of supporting one-to-one, one-to-many, and **distributed persistent** communications in a **local** area. Each MeshPhone will be capable of acting as a wireless **router** and **server**, automatically discovering and **networking** with other devices, as well as forming **gateways** to the existing internet.
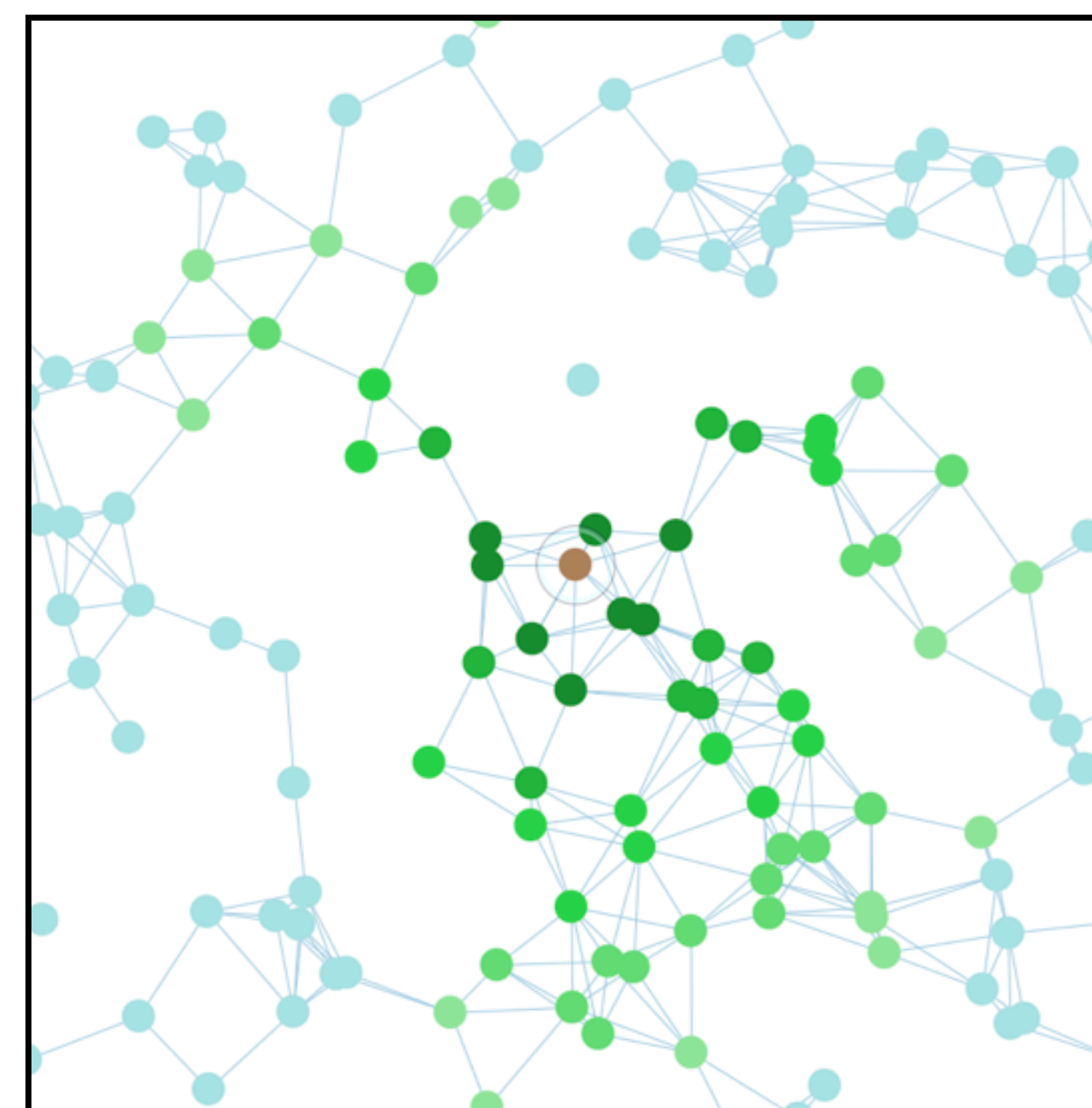
This network simulation shows how mobile ad-hoc mesh networking works. Each wireless device ("node") is shown as a dot, and lines show the point-to-point connections between nodes within radio distance.

Because every node is a router, messages can be sent through the network between nodes that are not directly linked. Nodes which are reachable from the central brown node in five links or less are shown in green.

Density provides robustness by redundant paths. Because devices can store information on behalf of others, device mobility increases information dispersal through the network.

The MeshPhone is being designed to provide low-bandwidth **asynchronous** packet-based communication and storage, sufficient for text, voice, and picture **messages**, as well as distributed software **applications**. Using **biologically inspired** techniques, we are engineering for:

- power **conservation**
- network **resilience** and **security**
- user **programmability** in **local languages**
- very low unit **cost**
- system **scalability**

results:

We have built, and are currently testing, four first-generation **hardware protoypes**, using eight-bit Atmel AVR microcontrollers and Hope RF12 digital radios in the unlicensed 900 MHz band, running the open-source FreeRTOS real-time operating system.

free RTOS
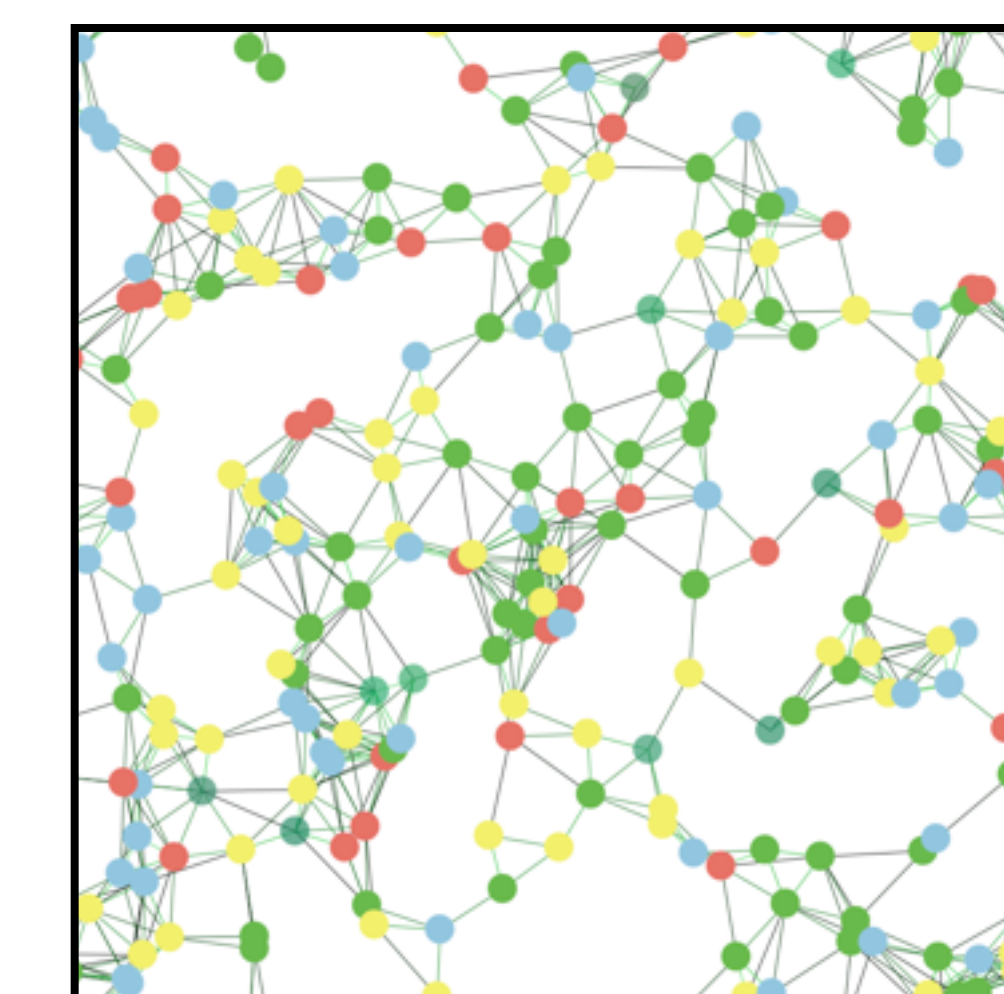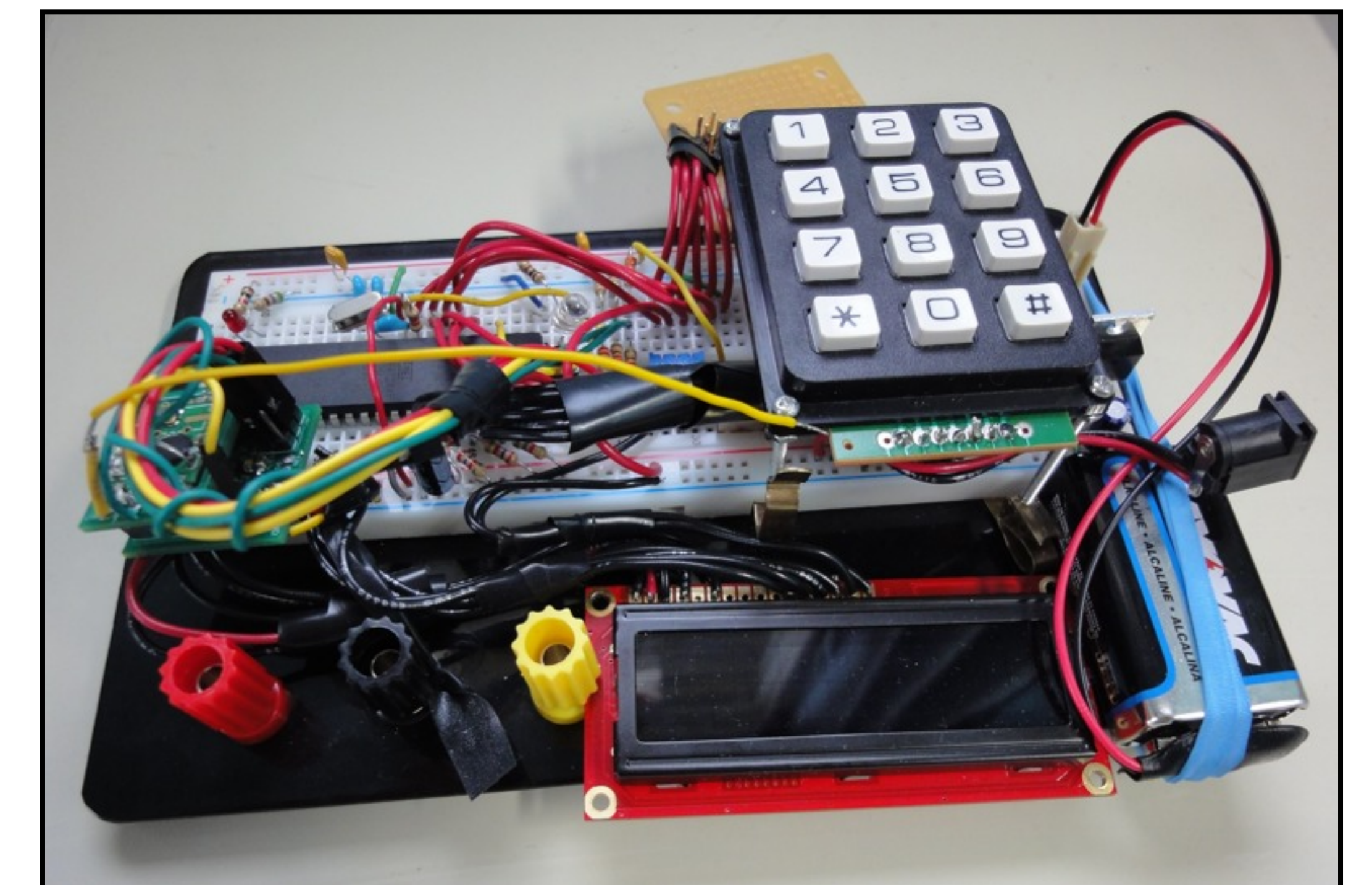
We are also developing a series of **software simulations** to test routing protocols and distributed services under large-scale network conditions, drawing from over a decade of cutting-edge research in mobile ad-hoc wireless networking.

This year we expect to build custom circuit boards for around two dozen prototype MeshPhones, capable of routing, storing, and forwarding text messages over a dynamic ad-hoc internet protocol network on the PSU campus. We are also investigating a second-generation design based on the 32-bit ARM Cortex M3 microcontroller and EverSpin non-volatile magnetoresistive memory, capable of hosting the Lua programming language for rapid development of user interface and application software.
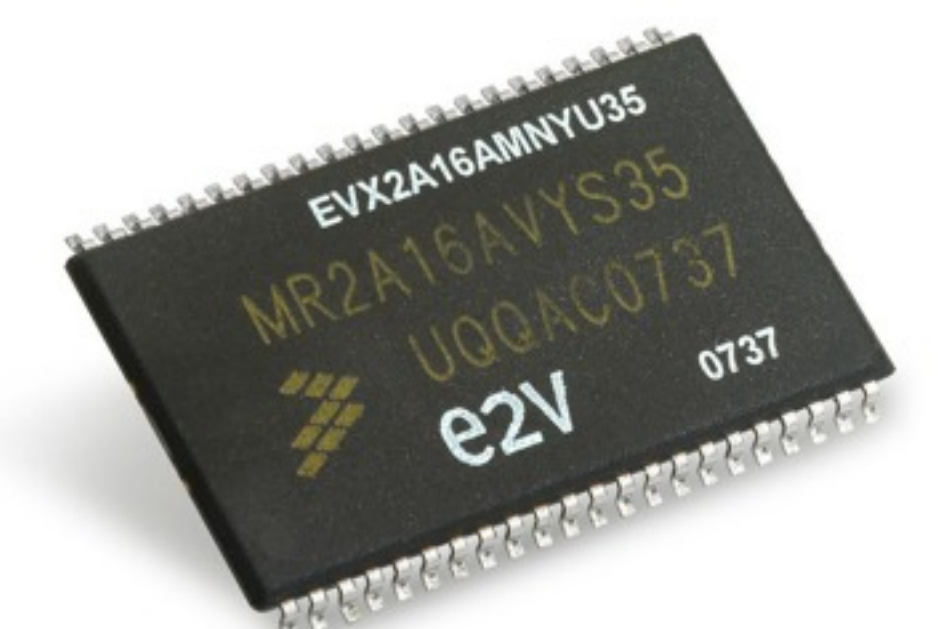
We're developing a digital communication infrastructure that everyone on earth can afford to participate in.