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From thin air

After my last column, I expected to be done with the topic of professional conferences for a time (**Reference 1**). Since that column, however, the Darnell Group presented the first annual NanoPower Forum with an outstanding and unusual program that I recommend to your attention (http://nanopower.darnell.com).

The NanoPower Forum pulled together a range of topics that, at first glance, do not appear to relate readily to one another. However, the topics jigsaw together to form a tightly coupled study of certain low-power applications. In all examples, the design goal was to implement a remote function with no signal or power leads connecting the function's remote location and the rest of the system.

Key among the presentation topics was energy harvesting by various means, including piezoelectric devices, thermopiles, and magnetoelectric devices. In many presentations, the energy these devices made available powered sensors or autonomous communications nodes, often both acting in concert. The applications for such devices cover a noteworthy range, including human-body implants, industrial-equipment monitoring, and sensor networks for commercial aircraft.

With such a variety of technologies, applications, and environments, one challenge the segment must face is the lack of clearly defined descriptors and specifications. For example, some presenters used the phrase "energy harvesting" to mean recapturing waste energy from the application under discussion. They used the phrase "energy scavenging" to mean capturing energy available from sources unrelated to the subject application. Other presenters and some attendees, however, seem to use the terms interchangeably or, at least, with less rigorous distinction. This difference is more than nit-picking: If a function is harvesting energy from the application in which it operates, then the designer can characterize the available energy with greater certainty than if the function scavenges energy from unrelated sources.

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For example, Boeing reported using a thermopile to power remote stress and corrosion sensors. The thermopile operates between the fuselage and the warm side of a nearby insulation blanket. During flight, the fuselage temperature is roughly −30°C, while the plane maintains its interior at or near 20°C for human comfort. The thermopile can power the sensors and their communication links from the 50°C in-flight temperature differential, and the application can tolerate the sensors being nonoperational when the plane is on the ground. By contrast, other presentations reported on scavenging energy from ambient-RF fields—an energy source that, as described, is uncorrelated to the subject application.

Beyond energy harvesting and scavenging, designers of such wireless, remote functions must contend with a variety of other distinctions. For example, does the remote function need to operate continuously or only intermittently? If intermittently, what is the duty cycle? What are the peak and average energy needs? Is the function critical or peripheral to the application? If critical, does it require multiple energy sources to ensure sufficient power under all operating conditions?

Is the energy source narrowband, broadband, or quasistatic? For example, vibration energy from the cases of rotating machinery is often a narrowband source. Ambient-RF energy is a broadband phenomenon. Thermal sources tend to be quasistatic. In each case, the bandwidth of the harvesting or scavenging mechanism must reasonably match that of its energy source. EDN

REFERENCE

1 Israelsohn, Joshua, "Confer for continuing education," *EDN*, May 24, 2007, pg 32, www.edn.com/article/CA6442440.

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