A powerless infra-structure…

In one or another way we are all familiar with base stations for wireless. Both on a large scale: the towers with big antennas that we connect to with our cell phones in some mysterious way to talk with the rest of the world, and on a smaller scale: with a wireless router at home that connects our computers to the Internet, as well as the computers of our colleagues and family members. Also in the wired networking world we are familiar with this so-called star networking concept with hubs, routers, gateways, etc. One would almost think that star networking (base-station/end node) would be the only feasible networking architecture. Not so.
There is also the concept of mesh networking, where technically speaking every node can talk with every other node in the network that is within range and without the need of going through a central base-station. Clearly, still one of the nodes can be dedicated to maintain connection to the "outside world" and serve as a gateway, but even that node is just "one amongst equals" – only performing a special function.
The nice specialty of a mesh networking configuration is the self-forming, self-healing character: with the help of a smart algorithm (and/or dumb tables) information finds its way ("hops" or "is routed") from source to destination along a path of intermediate nodes, and if for one or another reason that road is "blocked" (e.g. an intermediate node has dropped out or when infrastructure changes), that same algorithm finds an alternative route (assuming it exists). Although this may sound all very attractive, mesh networking topologies are actually quite rare. Frankly speaking, only the backbone of The Internet is a mesh, but besides that all other mesh networking implementations are quite exotic. However, the Internet as a network is very resilient, exactly because of the mesh structure of its backbone, and therefore mesh networks clearly hold a promise.

Meshing for wireless networks in particular is a problem for the simple reason that the nodes in a wireless network are usually running of batteries and that battery life is valued. For a mesh network to work effectively all the nodes must be "on" all the time, which drains the battery usually so quickly that meshing becomes impractical. Furthermore hopping over multiple nodes introduces "latency" and occupation of precious bandwidth. It is clear that when making a telephone call, one would prefer to be directly connected to a base station over hopping via a set of intermediate cell phones.

Interestingly enough for sense and control networks latency is not a primary concern and the amount of data transmitted is usually so low that hopping does not waste precious bandwidth. Therefore it is not surprising that ZigBee has included mesh networking in its standard. However… the current ZigBee specifications define the routing nodes as powered routers. Therefore, energy consumption is usually an issue for ZigBee nodes in a mesh network and consequently the ZigBee backbone has to be powered and ZigBee is usually implemented in the traditional star networking way. Unfortunately there are sensor applications really calling for mesh networking, in particular applications that cover large areas like in agriculture, foresting or larger building structures (dams, bridges, tunnels, dikes, pipelines, etc.). For these applications (that can cover multiple square kilometers) it becomes impractical to implement a base station infra-structure, because of the expense of power lines and data communication lines – making it attractive to find a solution for the power problem.

The outline of a solution for this problem exists in a combination of three technologies: (1) ultra low power radios, (2) synchronized networking and (3) energy harvesting. A proper system development enables the possibility that energy harvesting delivers enough energy for a node to come up (and to do its job) at regular time intervals while being asleep the rest of the time. It is important to realize that a node usually "works" for only 100 milliseconds and then can be asleep for 900 milliseconds, or even for 5 minutes.

This way a green house or even a forest can be populated with sensing nodes that interconnect via each other (in a meshing sense) to a central node for reporting values to the outside world without the need of a powered infra-structure: a powerless infra-structure.

A practical implementation is a using a GreenPeak LPR sensing network for controlling wildfires with Voltree energy harvesting. Voltree harvests metabolic energy from trees and converts it to useable electricity, in sufficient amounts to power a wireless mesh sensor network. With the proper dimensioning of the network, forest wildfires can be identified over a very large area in an early phase for a fraction of the cost of the damage caused by uncontrolled spreading.

cees.links@greenpeak.com

▸ www.greenpeak.com
▸ info@greenpeak.com

GreenPeak Technologies
T +31 30 262 1157 ▸ Utrecht - Netherlands
GreenPeak Technologies Belgium
T +32 52 45 87 20 ▸ Zele - Belgium
GreenPeak Technologies Japan
T +81 3 3783 0377 ▸ Japan
GreenPeak Technologies USA
T +1 512 464 1188 ▸ USA