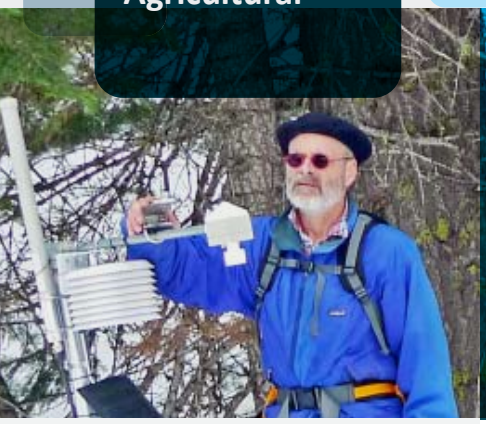
APPLICATIONS:
Energy, Industrial, Agricultural



Wireless Sensor Networks Make It Possible to Predict Precious Water Supplies

SUMMARY:
Dust Networks' wireless mesh network solution enables CITRIS to reliably gather real-time water content data from the snow pack, using 300 sensors distributed throughout a remote, mountainous and environmentally harsh one-half square-mile region in the Sierra Nevada Mountains of eastern California.

CHALLENGES: Researchers needed a dense, large-scale, low-cost wireless sensor network (WSN) able to reliably transmit under harsh conditions for long-term, maintenance-free environmental monitoring.

SOLUTION: The research team selected Dust Networks SmartMesh WSN technology. Combining ultra-low power Eterna™ technology 802.15.4 nodes and advanced Network Management, SmartMesh enables the long battery life and auto-forming, self-healing, multi-hop, mesh network required for remote monitoring.

THE CHALLENGE

Whether it is thermoelectricity production, agriculture, industry or hydroelectric production, snow and the surface water annually stored in snow is critical to the U.S.A.'s economy, with users of this water contributing $1.7 trillion annually (15%) to the Nation's Gross Domestic Product. In California alone, the contribution to revenue production from snow is almost 30% of California's GDP. Snow information is used to anticipate droughts and floods, to equably allocate water resources between the public and private sectors of the economy, and is key to agricultural planning.

The processes governing snow, snow melt and surface water in mountainous regions where snow accumulates are not well understood because they are difficult to measure. Up until recently, researchers relied on wired sensors that are sparsely deployed in remote locations with steep terrains, extreme environmental conditions including flash floods, deep snow and sub-zero temperatures, and animals with a penchant for gnawing cable. These wired networks are too expensive, unreliable, and difficult to maintain, with too few data points to create an operational picture of the watershed.

In a CITRIS (Center for Information Technology Research in the Interests of Society) – sponsored collaboration, Roger C. Bales, UC Merced, and Steven D. Glaser, UC Berkeley, were investigating ways to improve large-scale environmental monitoring, and turned to wireless sensor networks (WSN) to see if this technology could enable a more efficient, scalable and robust solution. "We needed a reliable WSN that could be dense in space and time, with multiple nodes within the same radio space, that could run on batteries for at least a year even with a high frequency of data transmissions, and that could function in a very harsh environment," said Dr. Glaser.

While they found many commercial wireless systems able to transmit data between two points, the hardware generally contained relatively high-powered radios requiring more energy than could be supplied by batteries alone. They also found that typical point-to-point transmission systems operated independently, with unwanted radio interference between nodes if multiple links were deployed too closely together (i.e., with overlapping radio transmission ranges).

THE SOLUTION

Dr. Glaser selected Dust Networks® SmartMesh™ WSN technology because of its long battery life, intelligent networking features and scalability. Ultra-low power consuming 802.15.4 SmartMesh nodes enable years of battery life. The SmartMesh network manager provides advanced, built-in technology to create an auto-forming, self-healing, multi-hop, mesh network. "These features are not standard on most wireless sensor networks," said Dr. Glaser. "Our environmental monitoring system would have taken significantly – even years – longer to develop if we had had to design and implement the stack-level controls and complex networking algorithms necessary to provide the features we needed."

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The communications system is comprised of Dust Networks' wireless nodes and a network manager. The nodes have highly integrated hardware, and configurable software interfaces for simple integration. The nodes transmit data every 15 minutes from remote groups of sensors measuring snow depth, solar radiation, relative humidity, soil moisture and matric potential, and temperature. Some nodes are connected directly to the sensor groups; others are used as "relay stations" to increase the reliability of transmissions over ridges, outcrops and heavy forest. The SmartMesh network manager supports large, dense, multi-hop mesh networks that form automatically, and expand easily. It also provides security management, detailed network statistics for optimizing sensor placement, deterministic node power management and optimizes the network dynamically based on built-in surveillance of the network's status. The network manager communicated the sensor data to a local computer via Ethernet. The computer is located at the base of a 40-foot tower, and a wired-in GPRS modem positioned higher in the tower provides Internet connectivity for the transfer of real-time data to an off-site location.

THE RESULTS

More than 300 sensors are deployed at 23 measurement locations with a network of 57 wireless nodes collecting and transmitting data for a one-half square mile region of the Kings River Experimental Watershed - a remote, vertically precipitous, forested, headwater catchment in the southern Sierras. Steven Glaser, Roger C. Bales, and their graduate student, Branko Kerkez created a WSN deployment methodology and showed that Dust Networks standards-based mesh network technology provides a reliable, resilient and scalable network solution that can meet the demands of an environmental monitoring application, by maximizing path reliability, battery life, and spatial coverage.

"Today, the water managers need to give conservative estimates on water availability," says Bales. "They have to, given what they don't know. If we reduce the uncertainty in their estimates in a way that people can use, we could pretty easily imagine adding a couple of hundred million dollars to the state's economy."

"Our environmental monitoring system would have taken significantly–even years–longer to develop if we had to design and implement the stack-level controls and complex networking algorithms necessary to provide the features we need."
Dr. Steven Glaser

Why Work with Dust Networks? Dust Networks is the leader in wireless sensor networking, delivering intelligent mesh technology when ultra-low power matters. Dust Networks is defining the way to connect smart devices. Using standards-based wireless mesh network technology, Dust Networks designs chips, modules and managers that create networks that are reliable, resilient and scalable with advanced network management and comprehensive security features.

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