Great Barrier Reef Sensor Project:

It is impossible to describe the stunning, captivating, tranquillity of a coral reef - it's something you have to experience for yourself. Unfortunately, our coral reefs are under threat from global warming, pollution, and other human activities. Coral bleaching, a key indicator of reef health, is becoming more frequent and the incidence of coral diseases may also be on the rise. Reefs comprise a complex network of symbiotic interactions involving thousands of species of corals, fish, and algae. Corals themselves are fascinating organisms. They rely on a symbiotic relationship with their algal partners zooxanthellae, which give corals their brown colour. When they are stressed they expel the algae, causing them to bleach to bone white or, in the case of corals that produce their own pigments, pink, pale blue, and yellow. Corals can survive short term bleaching, but prolonged severe events are fatal.

Although it is clear rising global temperatures are partially to blame for bleaching, it appears to involve a combination of causative events that has yet to be determined. It is known that approximately two months before a major bleaching event there is an unusual up-welling of water from the ocean deeps. Normal up-wellings are time of year dependent: they generally occur between November and March on the GBR and happen when the thermic line (the boundary between warmer surface water and cooler, deeper water) moves up 20 to 40 metres allowing strong currents to sweep slugs of cold water onto the continental shelf. In these events the cold water does not penetrate far across the continental shelf, but unusual up-wellings are more intense and can drive cold, nutrient rich water all the way to the shore. It is unlikely that the temperature drop alone caused by the cold water is responsible for coral bleaching as it amounts to only a few degrees and does not go below normal winter temperatures for the reef so the role of up-welling in bleaching remains unclear. To investigate this, and other aspects of the life of coral reefs, scientists are installing a smart sensor network to monitor the Great Barrier Reef (GBR).

The sensor network will function in many ways similarly to the internet. Each sensor is network enabled, can be given and IP address, and can be programmed and reprogrammed. They use wireless technology to communicate with each other and to send information back to a central location. Like the internet, if one sensor drops out of the network or a new sensor is added, they can reroute to accommodate the change.

Because they use microwaves, smart sensors can send much larger amounts of information much faster than the traditional HF radio systems that have been used to monitor the GBR up to now. They can also function over long distances by taking advantage of a phenomenon known as ducting. This involves a region of rapidly changing humidity just above the ocean surface, known as the evaporation duct, that causes refraction of microwaves such that they bend toward the earth and therefore follow the curve of the earth rather than sailing off into the atmosphere. Using this, microwave signals have been reliably sent over distances of 70km (the greatest distance from the shore to the GBR is 100km), unlike traditional line-of-site radio transmissions. Although satellite communication can also achieve this the cost is prohibitive, while the sensor network has been designed to use off-the-shelf technology to keep costs low. The GBR sensor network will consist of hundreds sensors around Davies Reef and Magnetic, Orpheus, Heron, and Lizard Islands and may eventually increase to perhaps thousands along the entire 2,000km length of the reef.

Information gathered by sensors mounted on buoys in the ocean will be correlated with data collected from the weather stations operating on the GBR. In addition, sensors equipped with video cameras and mounted on the weather stations are planned that will send back live video images of the reef.

The smart sensor network can monitor factors such as salinity, water temperature, light, and current. Because they are small and inexpensive, they can be positioned to compare these factors over both small (e.g. around a single coral) and large (e.g. between reefs) distances. This will allow scientists to examine both local and widespread events and their impacts over both small and large distances. The sensors can also monitor water quality, which has been linked to local, but not global, bleaching events. This will help to determine whether pollutants that run off into the ocean are damaging the corals reefs.

In addition to providing insights into coral bleaching, the sensors will be used to understand how the coral reef system normally functions at both the local and general level. Furthermore, because atmospheric circulation is driven by ocean circulation, the data gathered may also shed light on weather patterns, including el nino events. Similar networks are being established on the Moorea Reef in French Polynesia, reefs in the Florida Keys, and the Kenting Reef in Taiwan and are also being used to monitor some lake systems (see http://www.coralreefeon.org/).

The GBR sensor network is an exciting and ambitious project remarkable for that fact that it has never had formal funding, though it does have some sponsors. Like the internet, the coral reef sensor networks have been brought together by a casual network of interested and highly motivated collaborators known as the Coral Reef Environmental Observatory Network (CREON). The Great Barrier Reef team includes Ian Atkinson, Graham Woods and David King at James Cook University in Townsville, and Stuart Kininmonth, Ray Berkelmans, and Scott Bainbridge at the Australian Institute of Marine Science (AIMS).