Ocean Structures and Materials
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Module - 4
Lecture - 3
Wireless sensor networking

In the last lecture, we discussed about structural health monitoring and different kinds of networking which is generally done for collecting data or acquiring data related to vibration of marine structures. In this lecture, we will continue to discuss wireless sensor networking much more in detail.

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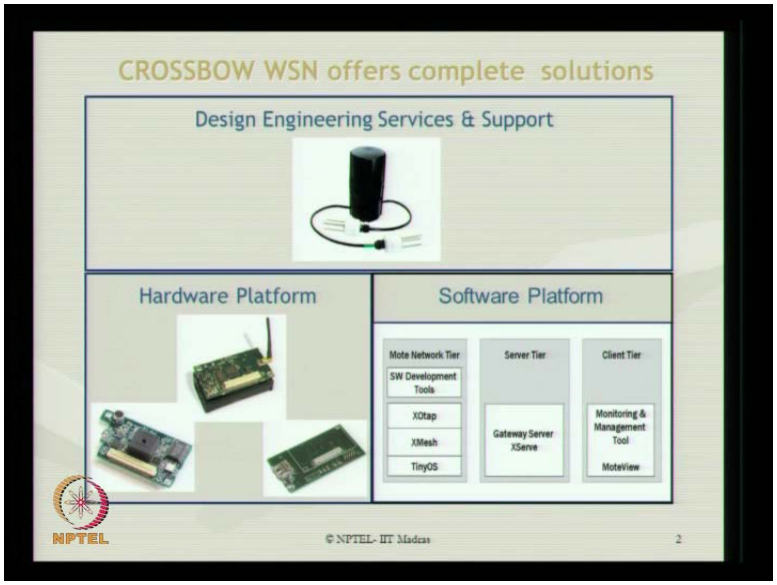

Crossbow technology USA offers a complete solution for wireless sensor networking inwhich we will see the anatomy of the proposed sensor networking with different configurations and specifications of equipment. The hardware platform is generally used as you see here and the software platform includes, the mode network tier, which we discussed in the last lecture, the development tools. Then the server tier is generally a gateway server and the client tier can be monitoring and management tools and what we call as the motel view is one of the software, which can be used for the client end. The design engineering service and support are generally depending upon what kind of sensors are using and what data you want to acquire.

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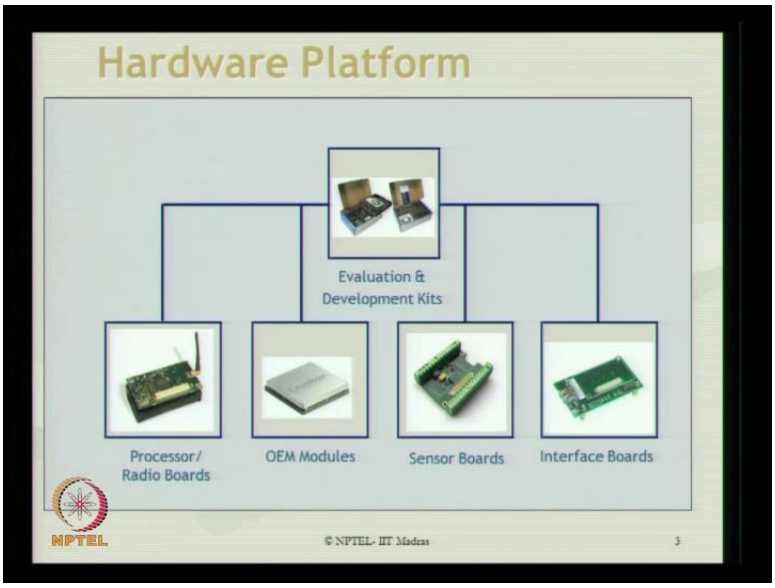

If you look at the processor and radio boards, they have a frequency capability or they can collect the signal using the antenna attached to the board, which you called as the radio board; it also comes with OEM modules. And the sensor boards which has got different configurations where different layout of sensors and the adoption cards can be plucked to it. And off course, it comes with lot of interface boards to keep on building them in series of connections. And it includes evaluation and development kids which is the hardware platform of the sensor networking.

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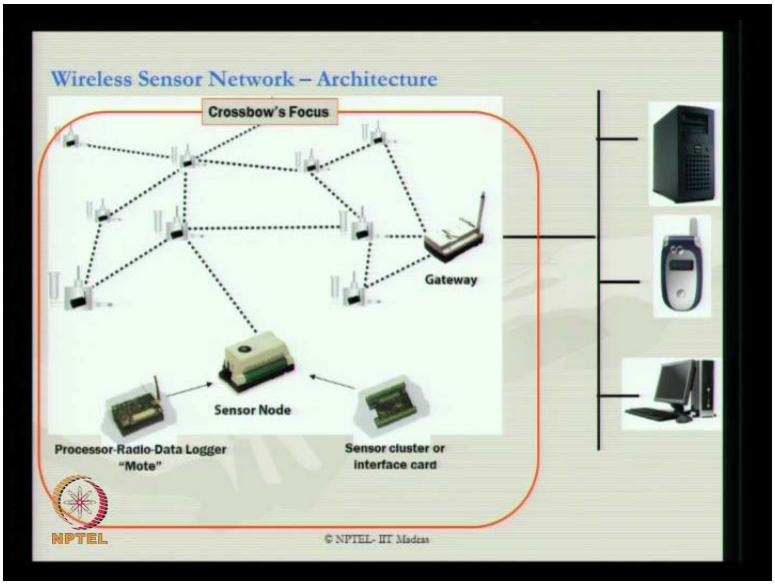

The wireless sensor network architecture, as we saw in the last lecture, has got individual sinks and sensors connected this nothing but a sensor node. And this is the process radio data logger which we addressed as mote in our discussion. And the sensor cluster can be arranged to connect various sinks and sources of different points, all of them connected through the gateway. So, now the gateway can be connected directly to a PC, can be connected to a laptop or can be also acquired and warning signals as similar to that of simcard in a mobile. This is area focus what crossbow devices for designer configuration.

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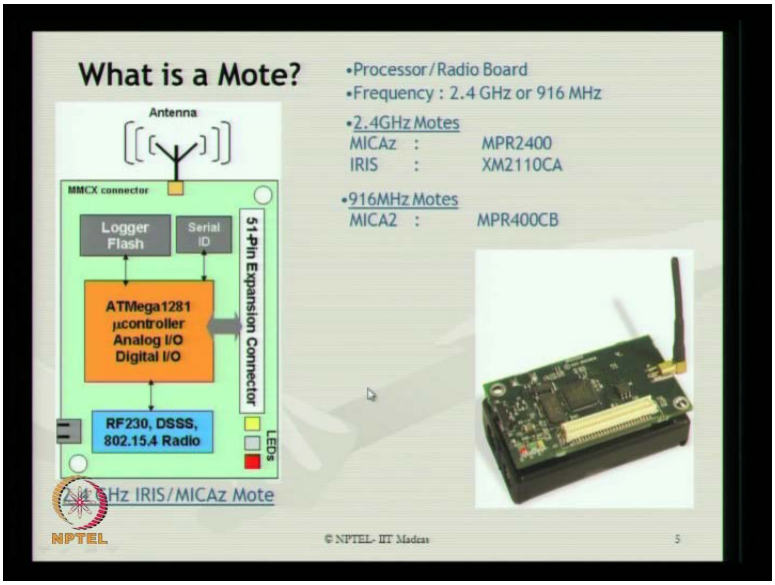

Now let us quickly understand more in detail, what do we understand by a mote? Mote configuration is what you see in the picture here, which consists of an antenna, which has got MMCX connector which is also having a logger flash and serial ID. And AT mega 12 21 mu controller - micro controller which is analog input and digital input output is well. And it is got RF 230, DSSS and the radio frequency at 802.15.4 which can operate with 2.4 Giga hertz IRIS with this mode configuration. It is also having a 51 pin expansion connector which can be used for connecting further configuration to this mote. And of course, it got LED indication to show different kinds of signal allowance in this system. The processor radio board is physically looking like this, which has got an antenna attached to it; and the frequency of the operation varies from 2.4 Giga Hertz from 916 Mega hertz.

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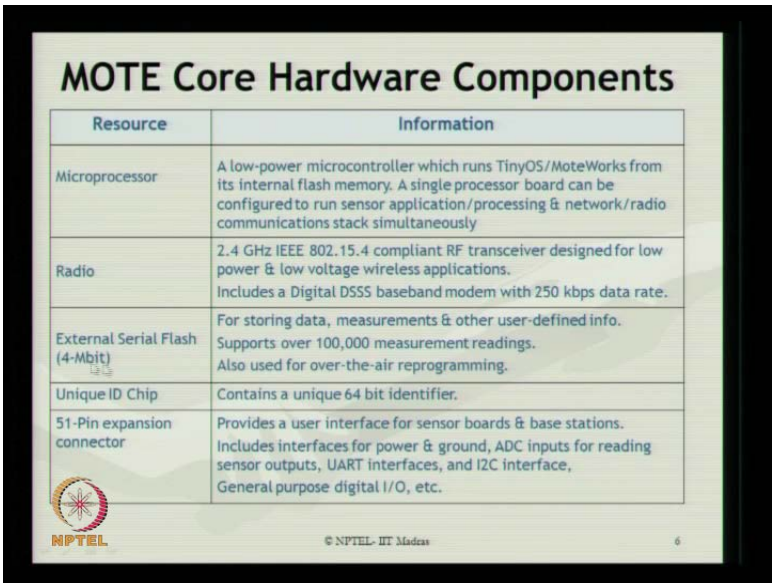

The two different configuration are shown; The mote core hardware components are listed as you see here. The microprocessor is the low power microcontroller, which runs tiny operating system, which is called as mote works from its internal flash memory. It consists of a single processor board, which can be configured to run the sensor application and processing. And off course used for networking and radio communication stacks simultaneously. It also has the radio, which is about operating at 2.4 Giga hertz I EEE 802. 15.4-complaint RF transceiver designed for low power and low voltage wireless applications. It also includes a digital DSSS baseband modem with 250 kbps data rate, which can be attached to the radio. The external serial flash is about 4-Mbit for storing data measurements and other user defined information, which are required to collected from the actuation system.

It supports over 100000 measurements reading, therefore can be continuously monitor and also used for over the air reprogramming as well. It is got a unique ID chip which contain unique 64 bit identifier; based on which the physical location and electronic configuration of the mote can be identified in your server. For that it has got the expandable connector which is 51-pin socket, which provides a user interface for the sensor boards and connecting for the base stations. It includes interfaces for power and ground, ADC inputs for reading sensor outputs UART interfaces and 12C interfaces as well. The general-purpose digital input output etcetera can also be connected to the expandable 51-pin connector in the mote.

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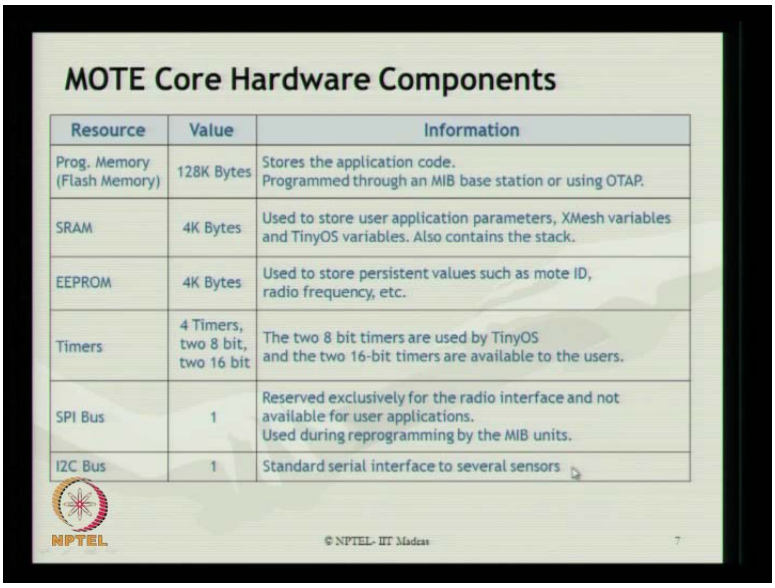

The mote further has a programmable flash memory, which is about 128 kilo bye. Stores the application code and off course programmed through an MIB base station or using OTAP configuration. It is having a 4 kilo byte SRAM used to store user application parameters, Xmesh variables and tiny operating system variables; it also contains the stack it can be connected to the mote. The EEPROM which is also again contains 4 kilo bytes used to store persistent values such as mote ID, radio frequency etcetera, which can be used to retrieve the mote configuration in a given network system.

The timers of course circuits will be help full which is consisting of two 8 bit or two 16 bit sockets. The two 8 bit timers are used by tiny operating system, and the two 16 bit timers are available for the user to continuously monitor or monitor any specific data at intermittent talk timing which can be said to be using this specific timer circuit. The SPI bus is used for reserved exclusively for the radio interface and not available for user application. It used during the reprogramming by the MIB units. It also has 12 C bus which is standard serial interface to several sensors which is can be connected to this Mote in a serial connection.

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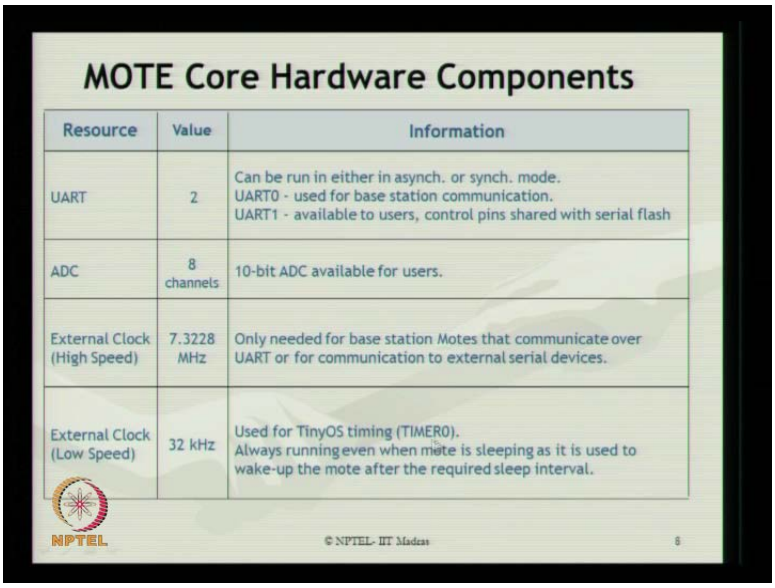

The UART can be run in either in asynchronous or in synchronous mode. UART0 is used for base station communication, and UART1 is available to user which can be used control pin shared with serial flash. The ADC 8 channel is used for 10 bit ADC available for user to connect the data acquisition systems, and off course external clock with an high speed of 7.3 Mega hertz is only needed when base station motes that communicate over UART or for communication for external serial devices. The external clock of low speed is used for tiny operating system which is called as TIMERO, always running even when the mote is sleeping.

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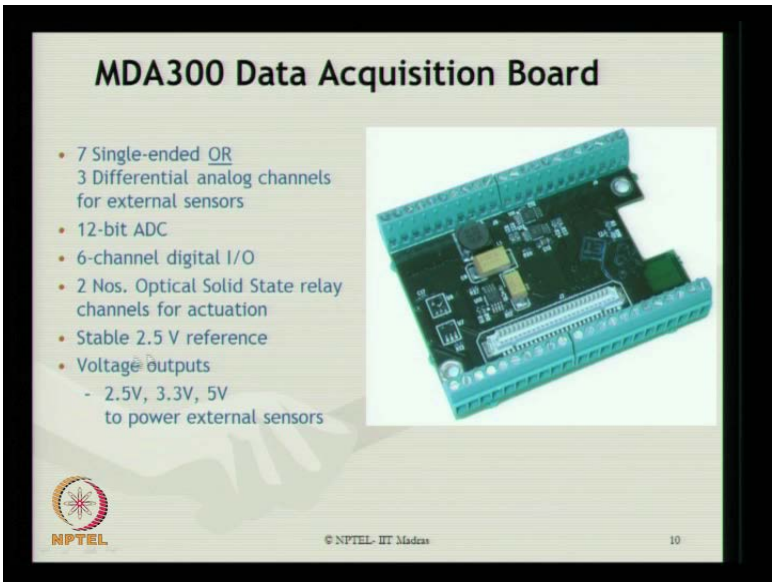

MTS300 310 sensor board is the basic configuration sensor. The sensor board looks like this which has got an expandable connector, which is having a photo resister, a sounder, a magneto meter, a micro phone collect the vibration of sound as well or tone detector, and off course it is having a accelerometer as well which can record the vibration on which this is been placed. The MDA300 data acquisition board physically looks like this. Seven ended or three differential analog channels for external sensor to be connected to the board. It contains 12-bit ADC and 6-channel digital input output configuration. It contains two numbers of optical solid state relay channels for actuation. It is stable at 2.5 volts reference voltage; and the voltage outputs are generally 2.5, 3.3 and 5 volts to power external sensors.

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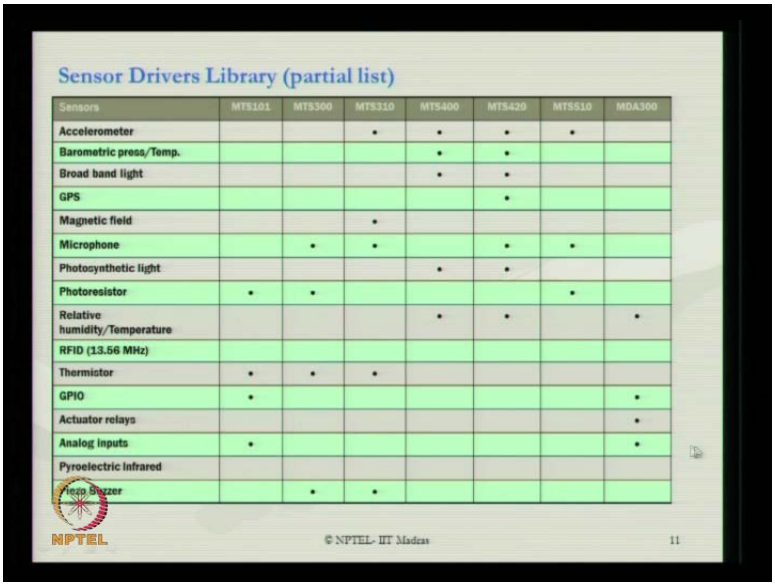

Look at the sensor driver library having the partial list as shown here. For different configuration mote as MTS 101, 300, 310 as available in the market as promote about crossbow USA. The most of these models have the accelerometer invert; they are barometric pressure temperature sensors; they got broadband light; they got GPS receivers; they got a magnetic field indicators microphone present almost in all the models, and photo resister. And of course, the Pizo buzzer and analog inputs which can be connected to the mote of the configuration.

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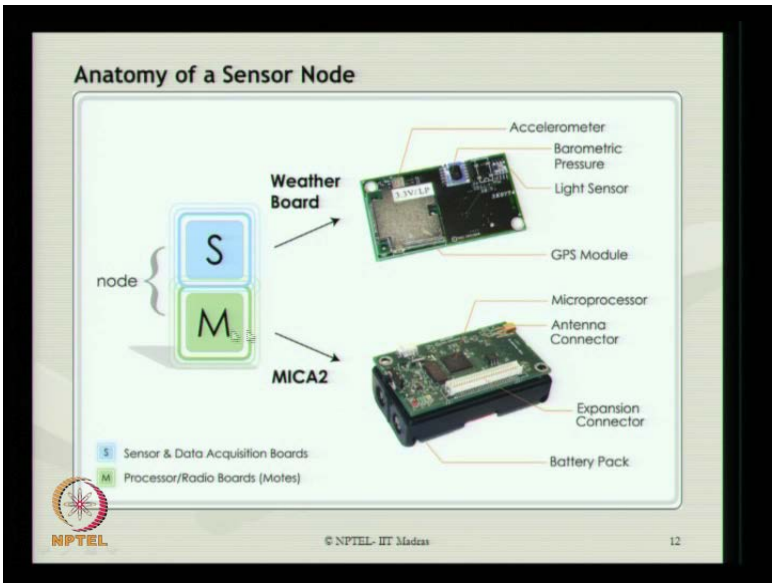

If we look at the anatomy of a sensor node, it looks like this, which is having two basic configurations- one is what we called as S node other what we called as M node. S node is essential for data acquisition boards, whereas M node is essential for processing or radio boards which are nothing but connecting the motes. The S board generally contains the weather boards; the weather board has a tiny accelerometer, a barometric pressure and the light sensor which can be connected. Whereas, M node which is MICA2 configuration contains the microprocessor and antenna connector and expandable connector to which you can connect further data acquisition system, and off course this comes with the self power battery pack which provided in the M node of the sensor.

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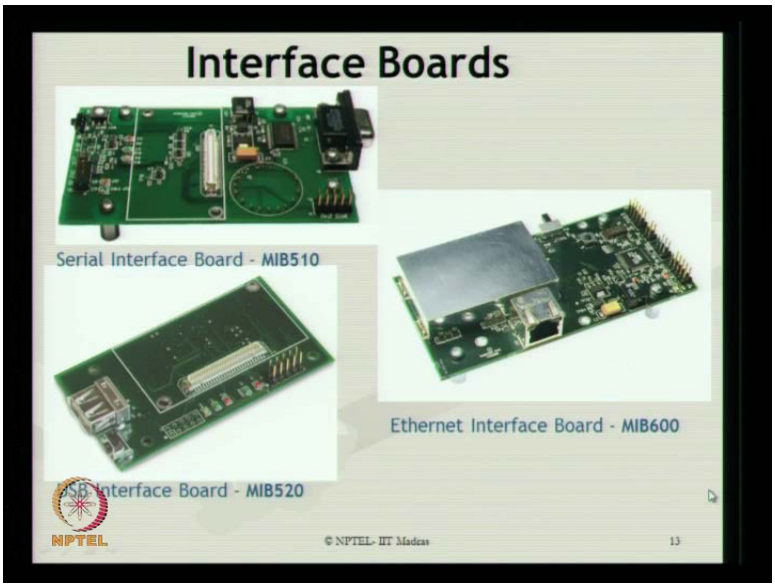

Let us talk about the detail of interface boards, which are used for this kind of sensor networking. It has serial interface board MIB 510 or you can also use USB interface board which is MIB 520 which can be connected to the USB card. It also has Ethernet interface board which can be connected data acquisition directly to the intranet facilities.

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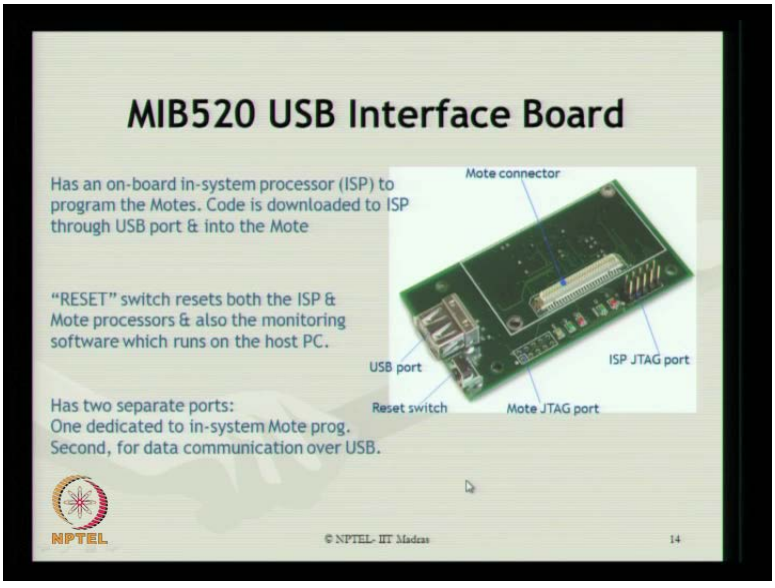

MIB 520 which USB interface board, which is more commonly recommended and used has a physical configuration of this form which is got a mote connector and USB port attached to the interface board. It has got an on board in system processor which is called

as ISP to program the motes. So, you can program the motes as per the time requirements and as per the frequency filters, as you desire to collect from the data acquisition system. The code is downloaded to ISP through an USB port and into the mote itself. The RESET switch resets both the ISP and mote processor, and also the monitoring software which runs on the host PC as per your choice. It has two separate ports one dedicated to in system mote programming and second one is for data communication over USB.

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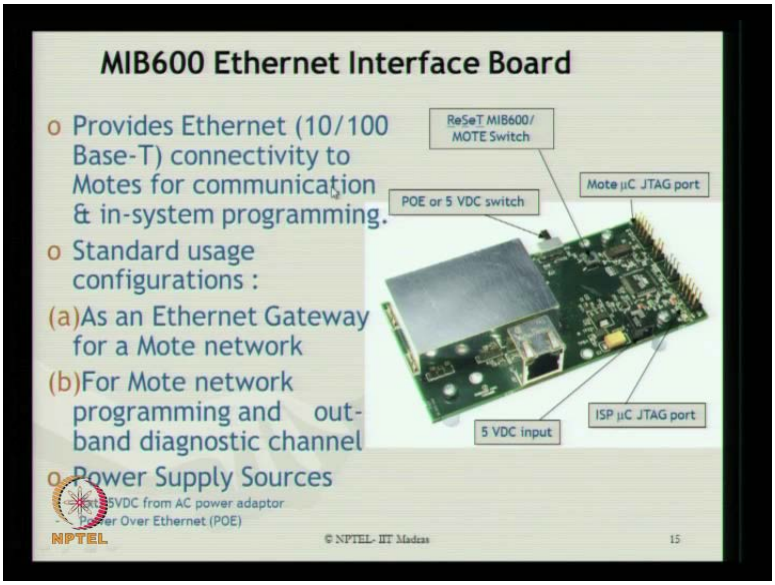

If we look at the Ethernet interface board configuration, physically the photograph of the interface board of Ethernet MIB 600 looks like this. It contains Ethernet 10 100 base T connectivity to motes for communication and in system programming. It has got mote microcontroller JTAG port, and off course ISP microcontroller JTAG port both attached to the interface board of MIB-600. The standard usage configurations are as an Ethernet gateway for a mote network or for mote network programming and out band diagnostic channel as recommended by the user. The power supply sources externally comes from a 5 VDC from AC power adaptor, the power over Ethernet POE switch is available in the board itself.

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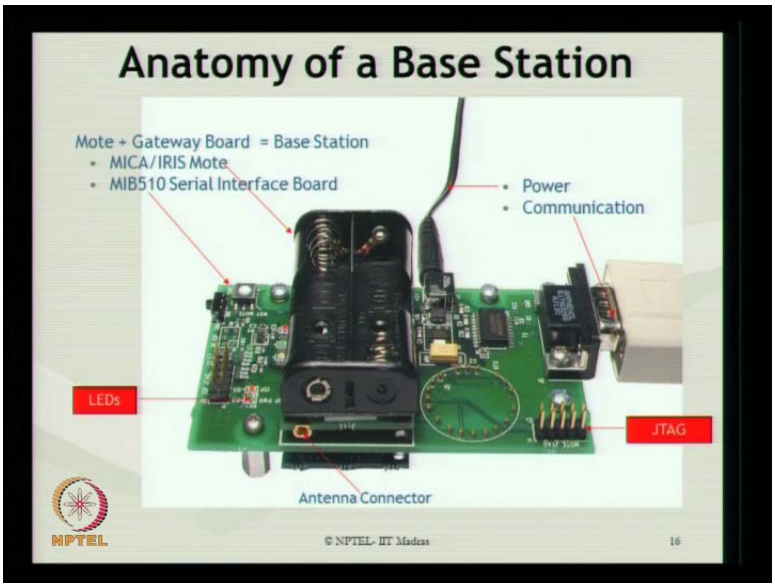

If we look at the anatomy of a base station, which is used for the sensor networking, the picture of the base station of the photograph looks like this. It has mote plus gateway board is what we called as base station. The base station has an IRIS mote which you can see in the black color. It is having an MIB-510 serial interface board as you see just now in the previous slide. It also has the communication receiver in the power battery which is powering this base station. Off course, it got an antenna connector which can be useful for RF communication signals. The JTAG port useful for connecting this to an Ethernet card, and the LED's are useful for showing or generating different alarm signals based upon the programming features available in the base station.

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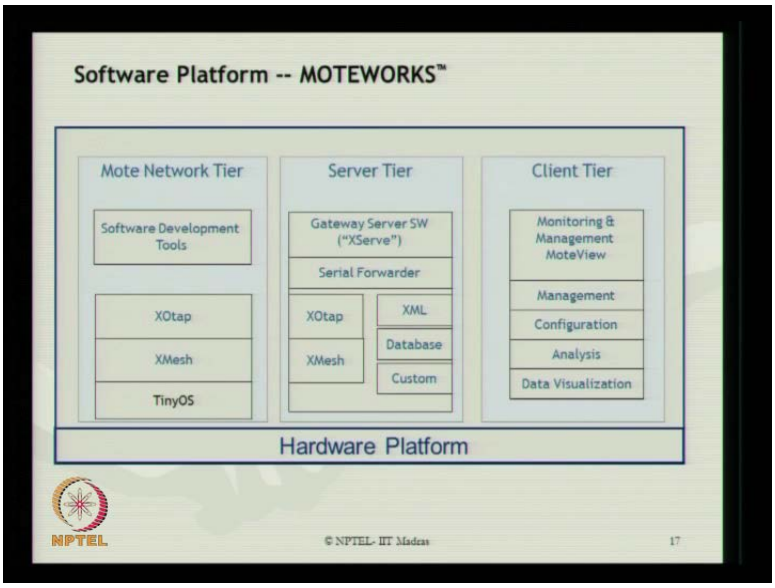

Now let us quickly look at the software platform on which this configuration works, which is nothing but called mote works. The hardware platform is what we just now saw. It is got the client tier, the monitoring and management mote view can be done, and management configuration analysis and data visualization all can be done in the client tier. The server tier has a gateway server, which connects the serial forwarder using the XML or database - the customized database. The mote network tier uses as the software development tools which can be configured externally using the freeware available in the crossbow site.

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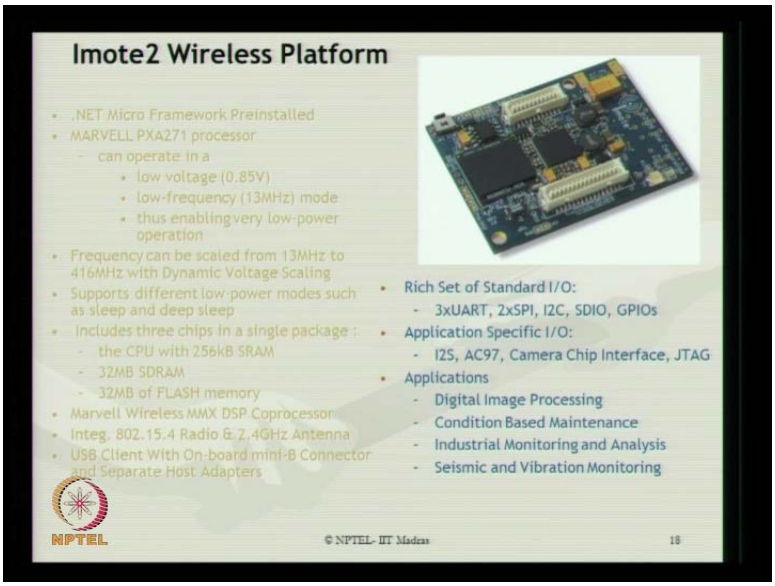

The Imote 2 wireless platform physically looks like this; contains the net micro framework preinstalled. It is got MARVELL PXA processor, which can operate in a low voltage about 0.85 volts; it operates a very low frequency 13 mega hertz mode. Therefore, it enables operation at very low power. The frequency can be scaled from 13 Mega hertz to 416 Mega hertz with dynamic voltage scaling which can be mostly useful for vibration acquisition in structures. It supports different low power modes such as sleep and deep sleep. It includes 3 chips in a single package the CPU with 256 kilo bytes SRAM, and 32 megabits SDRAM, and the 32 mega bit of flash memory is also available. MARVELL wireless DSP coprocessor also installed, integrate 802.154 radio and 2.4 Giga hertz antenna is also inbuilt in the wireless platform.

The USB client with onboard mini B connector and separate host adapter are also inbuilt facility in this platform. Having rich set of standard input output devices. The application specific input, output devices can also be available; can also connect the JTAG router a well as camera chip interface to capture photographs based upon the underwater video grapy. It has very wide variety of applications in digital image processing condition based maintenance, industrial monitoring and analysis, and seismic and vibration monitoring which are most useful in marine structures.

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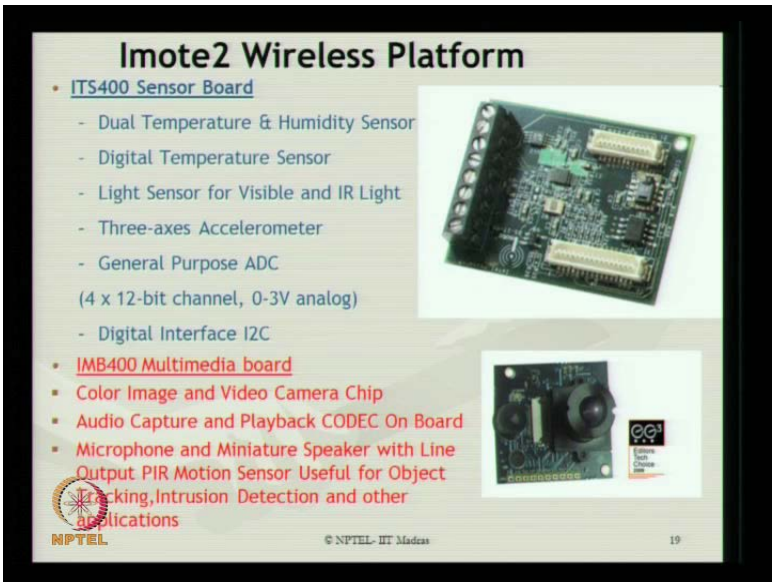

If you look at Imote 2 wireless platform, the photograph of Imote 2 looks as we show below. It contains an ITS-400 sensor board, which has got dual temperature and

humidity sensor, it is got digital temperature sensor, it is got 3 light sensor for visible and infrared light, 3 axes accelerometer inbuilt and general purpose ADC convertor also available with the digital interface of 12 C. It can process color image and video camera chipping, can also do audio capture and playback facility also available CODEC onboard.

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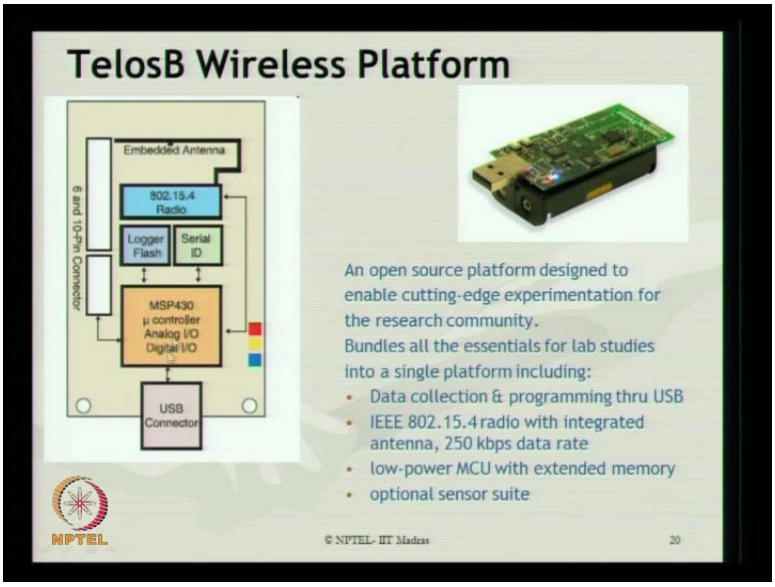

Now the wireless platform is having another configuration TelosB is look like this. Has an open source platform design to enable cutting edge experimentation for research community. The bundles are all the essentials for lab studies into a single platform including data collection and acquisition of data, programming through USB, I EEE802 radio with integrated antenna, low power MCU with extended memory and optional sensor suite can see the anatomy of the platform or the wireless platform TelosB looks like this; it is got an USB connector which can be connected an acquired. It is got a microprocessor controller analog input and digital input output is caller logger flash and serial ID, and off course embedded antenna which can be used for RF communication signals.

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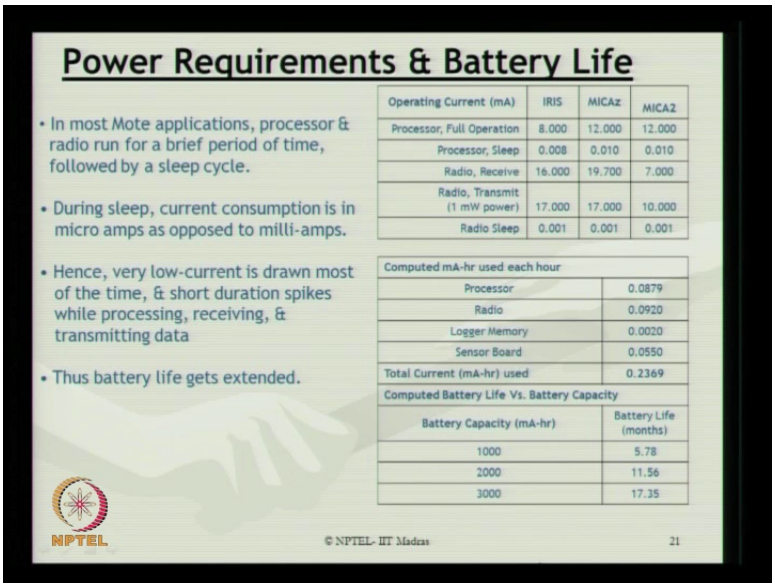

Let us look at the power requirements and battery life of these kinds of facilities. In most of the mote application, processor and radio run for brief period of time, followed by a sleep cycle. Generally, the mote or the sensor does not work continuously; it goes in a sleep cycle. Therefore, the operating current the milliamps for different configuration are available. The processor full operation requires 8 milliamps in IRIS configuration; in MICAZ and MICA 2 we got 12 milliamps. The processor when the sleep mode requires consumes only 0.008 milliamps. So, the power consumption when the mote in sleep mode is marginally less; it is very, very less.

And of course, the radio receiver uses about 16 milliamps signal in IRIS mode, whereas MICA models this is about approximately 19.7 and 7 respectively. Whereas, when you put them in the sleep mode, the power consumption is only about 0.001 milliamps in operating current. During sleep, of course, the current consumption is opposed to milliamps is very, very less. Hence, very low current is drawn most of the time when the mote is on the sleep mode, and short duration spikes while processing receiving and transmitting data. Therefore, the external battery life are available for these kind of configuration.

If you look at the computer milliamps used each are the processor user 0.0879 milliamp per hour used for each hour. Off course, radio memory and sensor board respectively consume, whereas the total current is only about 0.23 milliamp per hour is used.

Therefore, the computer battery life at different capacities of batteries are available; comes to approximately varying from five months to about 1 and half year. So, it sustains, self inbuilt power supply units which can be comfortably used for data acquisition for 24 into 7 continuous monitoring.

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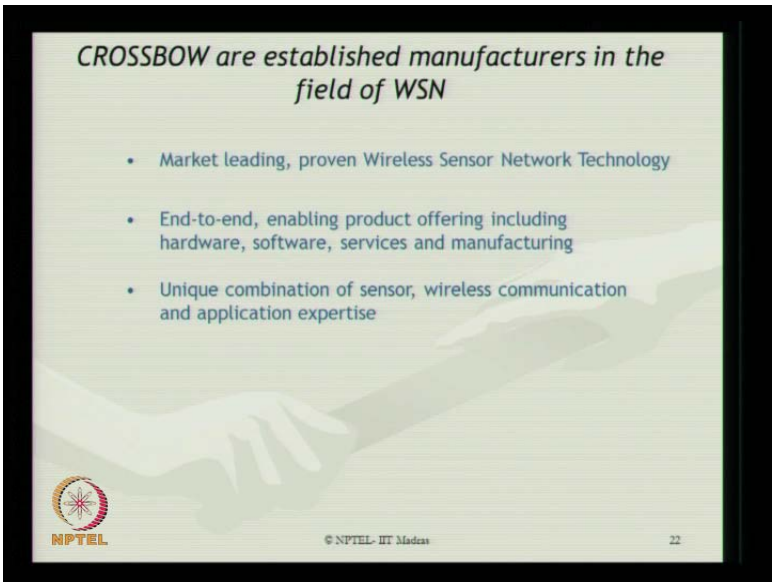

Of course, crossbow is established manufactures in the field of WSN. It is gone crossbow establishes manufacture in the field of wireless sensor networking. It is got market leading, proven wireless sensor network technology. It has end to end enabling product offering including hardware, software services and manufacturing. Off course, they gave unique combination of sensor, wireless communication and application expertise.

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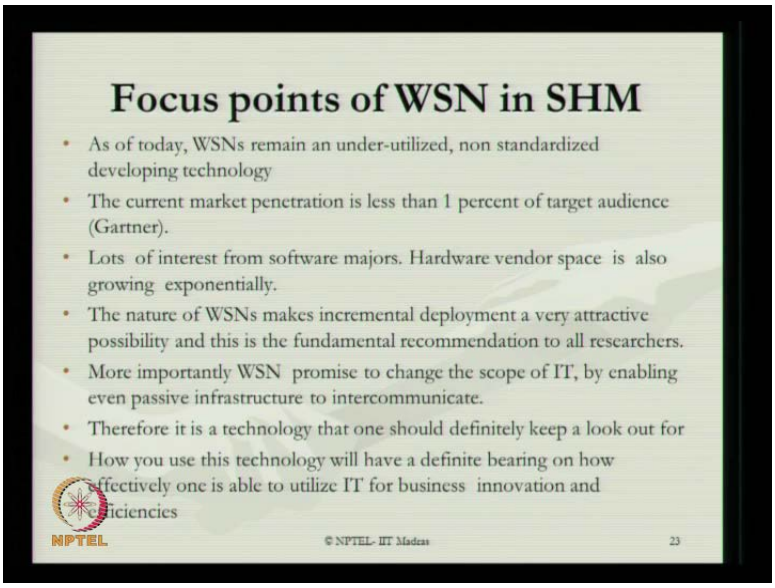

Let us again reiterate some of the focus points in wireless sensor networking used in structural health monitoring. As of today, ladies and gentlemen, wireless sensor networking remains underutilized or non- standardized developing technology. The current market penetration is less than 1 percent of the target audience. Lots of interest from software majors is available, hardware vendor space is also growing exponentially. The nature of wireless sensor networking makes incremental deployment a very attractive possibility, therefore fundamental recommendation to all researches that we must use wireless sensor networking for health monitoring of offshore structures. More importantly wireless sensor networking promise to change the scope of IT by enabling even passive infrastructure to intercommunicate. Therefore, it is a technology that one should definitely keep a look out for. How you use this technology will have a definite bearing on how effectively one is able to utilize IT for business innovation and efficiencies.

So, ladies and gentlemen, in this lecture, we saw extended version for different hardware configuration which are used for wireless sensor networking. In the last lecture, we discussed about some of the components to be used for structural health monitoring. With the both lectures put together, you will have an idea that how one can enable planning wireless sensor networking for acquiring or maintaining or inspecting and repairing and reutilization of marine structures and costal structures as a whole.

Thank you very much.