Voyager is a sea-going QRSS beacon project named after the famous Voyager space probes.

The plan is to build at least two Voyagers and launch them into the North Sea from the East UK coast a few weeks apart. SIMPLICITY is vital: that is, a reasonable degree of simplicty whilst still having fun - it is crucial to be able to actually launch a working beacon rather than just dream about the ultimate list of features.

Some preliminary design notes follow...

FREQUENCY & MODES

The original inspiration for the project comes from the world of QRSS. Power on the craft will be limited and therefore the RF output power will be limited. This pretty much determines that the transmission should be in a QRSS mode. The chosen band is 40m since propagation should permit reception around the North Sea coasts (UK, The Netherlands, Belgium). The distances involved will be too short for 30m propagation to be suitable. The short antenna length and therefore poor antenna efficiency will mean that 40m is probably a better choice than 80m where the antenna efficiency would be even worse.

The operating mode will be QRSS. Traditional QRSS is just very slow morse (CW) but this mode is somewhat inefficient since a dash is three times longer duration than a dit. It is also vulnerable to interference - experience on 30m QRSS has shown that plain QRSS under weak signal conditions appears very similar to interfering carriers: it appears on decoder screens (e.g. Argo) as horizontal line fragments. An FSK CW signal is much clearer to decode on QRSS screens. The disadvantage of FSKCW or DFCW is that the carrier is always on, which is wasteful of power. Better to have dashes signified by a carrier on and dits by carrier off. But, this is QRSS again... so how about a mode where we send dashes directly. A dash signifies a binary 1, an absence of a dash signifies a binary 0. Since patterns have been shown to be very readable even in weak condx, this should propagate rather nicely. The appearance on the screen would be something like:

// / / / /// / /

which means:

110100101001110101

We can also synchronise the start of each bit transmission so that listeners know when to expect data. QRSS dot lengths of around 5 seconds are very popular. So suggested mode will be binary encoded telemetry containing a carrier off for a 0, and a carrier on for a 1. A "1" bit will be signified by an increase in frequency of 5Hz over 5 seconds.

Planned message format would include position, callsign, and instrumentation telemetry. The message duration would be approx 10 minutes and the same message would update once per hour, being repeated six times in each hour. This gives six chances to receive it!

The WSPR mode could also be used - perhaps transmit in WSPR (just callsign, power and position) 5 times during one of the 10 minute frames. Therefore the hourly transmission would consist of the message sent five times in slash-QRSS and the WSPR message also repeated five times.Transmitting WSPR will require that the AVR knows how to convert position information to WSPR codes.

POWER

The simplest power supply should be just a set of eight D-cell batteries. They also make a nice weight to put at the bottom of the craft to keep it stable. My reading of the Duracell datasheet indicates that eight D-cell batteries ought to have enough energy to power a 50mW transmitter at 50% duty cycle for 2 months, which seems like a reasonable mission duration.

CONTROLLER & TX

Since we love AVR's we'll use the ATmega88 which has plenty of power. The ATmega88 will be clocked directly at the RF output frequency. FSK can be applied by voltage to a varicap diode (e.g. LED in reverse bias) from a PWM output of the AVR. The buffered oscillator output on pin 14 will drive a 2N7000 Class-E RF amplifier putting out approx 50mW. Likely antenna might be a loaded whip with sea-counterpoise, or a helical whip. The whip length would probably be only 1 to 2m.

HULL

Likely best way to make a robust hull will be to use plastic drainpipe, with end caps glued on at either end. Means has to be found to allow waterproof entry and exit of cables into and out of the hull - e.g. the whip antenna, sensors, GPS antenna, probes on the down-facing side.

INSTRUMENTATION PAYLOAD

The fun part of the mission will be to pack in many different types of instrument just for the fun of returning data from somewhere in the North sea for some weeks. The list of possible instrumentation to be carried below might change: some might not be practical, others might be added... we shall see!

GPS

First and foremost, must come the GPS positioning system. XAR and UPL have Thales B12 GPS systems and patch antennas. The plan would be to operate the GPS receiver for a few minutes each hour, to obtain a fix. Then put the GPS receiver into standby mode for the remaining minutes of the hour. The transmitter would not be operating while the GPS is getting its fix. Standby backup power to the GPS ensures "hot start" conditions which means it should get its fix very quickly. The returned GPS data will consist of longitude and latitude. Date and time are unnecessary: the receiving station will already know these!

System Data

The system data component of the telemetry will give the state of the craft and its systems, as follows:

1. Battery voltage
2. RF Output power
3. Hull integrity bit ("1"means Ok, "0" means a leak!)

Sea Temperature

The sea temperature can be measured using a digital temperature measuring chip - I have a SE95 for this purpose.

Light Intensity (sunshine monitor)

Light intensity can easily be monitored via a CDR on the top of the craft.

Wind speed and direction

Wind speed is much harder to measure and wind direction even harder too. I feel that a conventional rotating cup anemometer is too difficult to mount reliably on the craft and may be difficult to waterproof and easily corrode in the harsh sea conditions. A solid state alternative would be greatly preferable. It seems a better way is to measure rate of wind-assisted cooling and this method isn't new - google "hot wire anemometer" or "thermistor anemometer".

My suggested implementation of this idea consists of a surface mount transistor as the heating and temperature sensing element. A controlled about of heat can be applied to this tiny device protruding above deck of the craft and the rate of cooling measured. This to be compared to a reference internal temperature (i.e. out of the wind). The small heat capacity of the SMD transistor and sensitivity of the measurement once suitably amplified and processed means the average power consumption of this method should be mimimal. I can do an accurate calibration of the device against a "real" rotating cup anemometer I have here at G0UPL HQ.

Wind direction is much harder. I have an idea that it could be accomplished on a fixed instrument using a number (3 or more) of wind speed sensors mounted pointing in different directions. This combined sensor could measure speed and direction by looking at the relative rates of cooling in the different direction sensors. Not very easy to do! A big problem with that approach is that it measures only the direction relative to the craft. Therefore it becomes also necessary to measure the orientation of the craft relative to magnetic north. Also a difficult prospect! Digital compasses are available but not very cheaply. So I will investigate using Hall effect devices to achieve this. I have some hall effect sensor samples for this purpose.

Salinity

By measuring the resistance of sea water between two electrodes protruding from the bottom of the craft, it would be possible to calculate the salinity. A calibration can be done in "home" conditions using known salt concentrations.

Plankton

Plankton level may be said to be proportional to the murkiness of the seawater and could be measured by shining a light beam through the water and measuring the relative attenuation.

Ocean swell

We can easily measure ocean swell using a 3-axis acellerometer chip and I have some free samples of these to play with. I already played with interfacing them to an ATmega88 and it's really easy. A calculation will be needed to obtain some kind of "swell level" indication.

Surface spray

By putting two electrodes on the deck of the vessel it is possible to see if there is spray on the deck or not, by measuring the resistance between them. Not a useful thing really, but so what.

Other possibles:

1. Air pressure?
2. Humidity?
3. Any more?