TB-1301C
Important Steps in Designing a Telemetry System

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The following are the basic steps that should be followed when designing a Fish or Wildlife Telemetry System.

1. Determine detection zones. These are the physical locations you wish to detect tags in. It is often handy to refer to a map or profile of the site being studied, drawing coloured regions where detection should occur.
2. Choose appropriate antennas and antenna placement to cover desired detection zones. Large surface areas often require Yagi antennas whereas deep underwater locations require underwater dipoles or stripped coax. Antennas can be amplified and combined to create irregular detection zone shapes. Some interface with facility operator may be required to get assistance with antenna installation or permission for antenna placement such as on a dam where divers may be required to mount antennas in strategic underwater locations. Distant locations may require high gain or phased antennas. Speak to an engineer for advice if you have a unique challenge.
3. Determine appropriate receiver location. This location should be conveniently located close to power and possibly Internet yet be relatively central to the antenna locations feeding into it. If necessary, long antenna transmission lines can be created using amps. If no site power is available, solar panels will likely be necessary. Internet connectivity can be provided via cellular data connections.
4. Design transmission line network including positions of amplifiers, combiners and attenuators. If antennas are located at significant distances or combined with others, it is desirable to install amplifiers to offset the losses so that the antenna is nearly as sensitive as if the receiver was right beside it. There is some complexity to this process because it requires care in balancing the level of the inputs to the receiver and ensuring that sensitivity is preserved through the system. (See paper on antenna amplification, TB-1201).
5. Draw a schematic noting distances and/or cable losses, combiner losses, amplifier gain, etc. For large, complex, multiple antenna systems, this wiring schematic will be useful to visualize signal flow and troubleshoot performance problems. The schematic will also help describe the system in any papers or reports. It will also be useful to calculate proper attenuation levels and assemble a parts list for purchasing.
6. Calculate approximate attenuation required. When using long transmission lines and combining antennas, it is important to balance the signal contribution to the receiver from each antenna so that the sensitivity and performance of all antennas is similar. This will help minimize the bias on your results imposed by the system performance. The main way to balance antennas is to amplify and add attenuation so that the net gain from each antenna is zero at the receiver. With the schematic, you can write in gains and losses of each segment of the line and calculate what you would need as the final attenuation to balance it out. You can use this number to purchase attenuators in the range of what you would expect to need. Some amplifiers (i.e. Sigma Eight VHF amp) have built in attenuators eliminating the need to purchase external attenuators.
7. Create parts list (bill of materials) and purchase parts required. There are various sources for the components you need for a telemetry receiving system. Transmitters, receivers, amplifiers and

antennas are available from specialized telemetry companies (i.e. Sigma Eight). Cables, connectors, combiners, attenutors, etc. are generally available from electronics distributors. Sigma Eight Engineers can source and supply these components for you or direct you to the appropriate companies.

8. Install the system. This is the fun part. You could start by installing your antennas or coax lines first, in either order. You will probably have some on site challenges to sort through for antenna mounting. You may need to take a few trips to the hardware store to rig up a special mount based on the unique mounting options available to you. After the antennas are installed, you can run your coax cables between the antenna and receiver locations using cable ties, tape, conduit, etc. Be sure to leave extra cable at the end and at locations where amplifiers will be installed. Install BNC connectors at these locations. Finally, install the amplifiers, receiver box, receiver, power supply system, cellular radio, etc.
9. Use a beacon to balance the system. Get a reference level by attaching the beacon directly to the receiver input. Attenuate the beacon if necessary to get a level of about -75dBm. Attach one antenna at a time while balancing so that noise from unbalanced lines do not affect measurement. In a noisy radio environment, it may be necessary to disconnect previously balanced antennas as well. Attach the beacon to the location where the antenna plugs into the line at the far end. Adjust the line attenuation until the net gain is zero.
10. After all lines are balanced, set up the receiver by adjusting the noise floor suitable for the noise environment. Move the noise floor down enough to just start to get a few noise events per minute, but not so far that noise events are streaming out.
11. Verify final system using a test tag close to each antenna. Dip test tag in water near underwater antennas, possibly using a float and weight, to make sure coverage is as desired. If there are problems, you might have a problem with your antenna or antenna jumper. The line should be OK since it was tested during balancing but you could verify that you have not lost power to the amps or a line was not cut.
12. If possible leave the system for a week before the experiment to collect noise data and see if there needs to be any slight adjustment in the noise floor to cover changes in noise over time.
13. Perform weekly tests with a test tag throughout field season and be sure to log your results. Also log battery voltage and any other pertinent observations/changes.
14. It is a good idea to have a beacon tag continually running at a low rate, perhaps once every 5 minutes, so you have a continuous log of system performance and know exactly what time the system went down if there is a problem.

This is just a brief overview of the steps you should be considering to help guide you through the setup of your study. There is a lot of detail to each one of these steps. If you are just beginning with telemetry, please be sure to contact our engineers for more information and guidance. The can be reached at support@sigmaeight.ca or 905-833-0061.