Communications Overview

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ESP Networking Protocols

- FTP (File Transfer Protocol)
  - Fetching logs, images and sensor data files
    - The ESP GUI requires FTP access
- SSH (Secure Shell)
  - Encyrpted remote interactive sessions and file transfers
- SMTP (Simple Mail Transfer Protocol)
  - Status update emails
- HTTP (HyperText Transfer Protocol) [optional]
  - Alternative to FTP for browsers (like Safari) that don't support it
- Telnet (Look ma, no acronyms!) [optional]
  - Ancient, insecure alternative to SSH
  - May be disabled if security is a concern

ESP Ethernet Networking

- Just plug your new ESP into your lab network!
  - The ESP will appear as a host with the name you assigned it!
    - Requires your network accept new hosts with self-assigned names
    - If your network does not work that way
      - You likely have network admin people preventing this
      - See if you can cajole them to enabling DHCP and DDNS
      - Failing that...

- Connect a laptop and the ESP directly to each other
  - They must be on the same cable or the same ethernet switch
  - The ESP will be available at IP address 10.10.10.10
  - Configure your laptop to IP address 10.10.10.x where x != 10
  - Via this initial “direct” link, alter the ESP's networking for your needs.

    ```
    #  vi  /etc/sysconfig/ifcfg-eth0
    ```

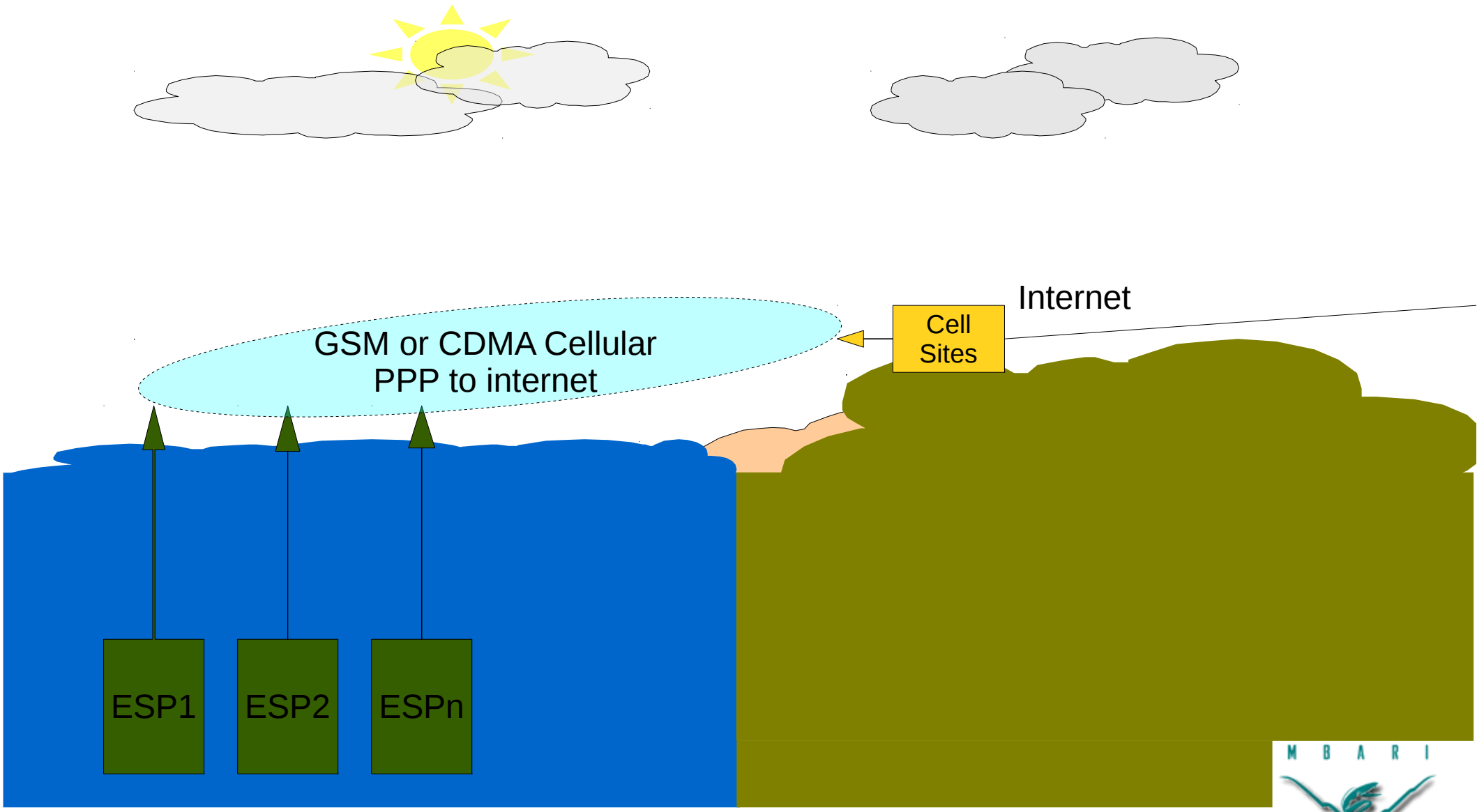
  - Will likely no longer “just work” when moved to other networks.

ESP Serial Console

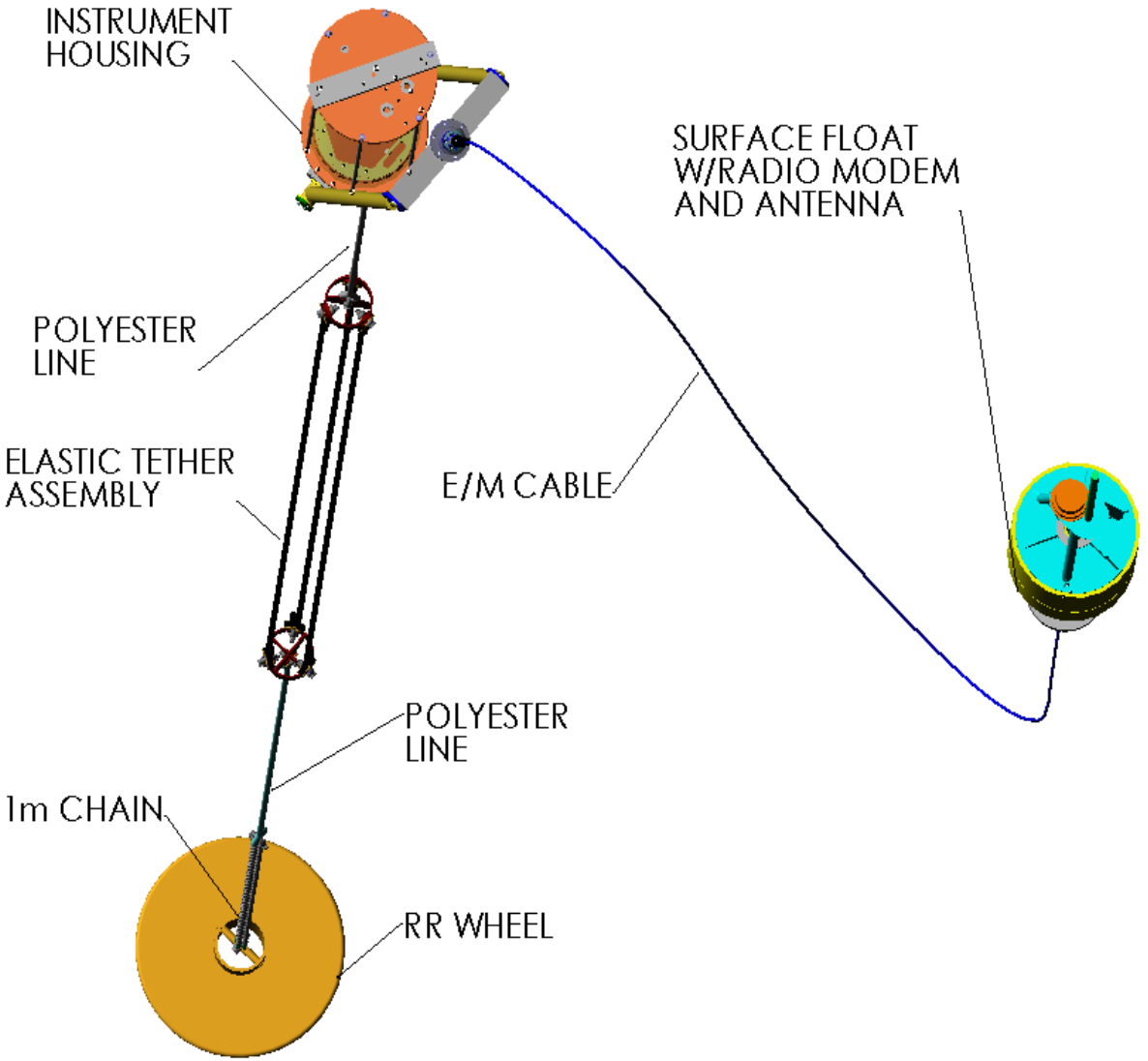
- A direct link between your laptop and the ESP
  - Cannot be used to transfer data files
  - Useful for debugging
    - And initial network configuration, when all else fails.
  - Typically requires an RS-232 ↔ USB adapter
  - Run a “terminal emulator” program on your laptop
    - 115.2 Kbaud, No Parity, 1 Stop bit
    - 3-wire interface – no handshake lines.

- Login with as usual
  - Remember to logout before unplugging the serial cable.

ESP Networking
via Cellular Radio Modems



Shallow 10-30m Mooring



GSM Cellular Modem
Sierra Wireless AirLink FXT009

- Compatible with T-Mobile and AT&T neworks in USA
  - As well others in most of the rest of the world
- RS-232 (slow) serial interface
  - 115.2 kBits/s – RTS, CTS, and Carrier Detect required
- Uses old GSM '2G' technology
  - AT&T plans to sunset their 2G network on 1/1/2017
  - T-Mobile is committed to continuing [but limited] support
  - Both companies are frustrating to deal with
- Uses mini SIM cards just like those in many phones
  - Deployments typically use < 150MB data / month
  - Cards expire after a few months of non-use

CDMA Cellular Modem
MultiTech MTCBA-C1X-N3

- Only compatible with Verizon network in USA
  - Little coastal coverage in Mexico or Canada
  - Nothing in Europe or Oceania
- RS-232 (slow) serial interface
  - 115.2 kBits/s – RTS, CTS, and Carrier Detect required
- No SIM cards
  - Service is tied directly to the modem itself
- Excellent customer service and web account administration
- Long latencies
  - Anytime link is idle for more than a few seconds

Freewave Radios
900Mhz Unlicensed

- Build your own cell site!
  - No frustrating cellular providers to deal with!
- Not used in the past 2 years for ESP deployments
- No data fees, but expensive equipment and maintainance
- About the same effective speed as commercial networks
  - But much lower latency
- Might make sense today for densely covering a bay
  - One shore site can could service 20 or so ESPs
  - A well sited shore station can cover 8 miles over 130 degree arc.

http://www.freewave.com/files/datasheets/FGR115RC_WC%205.14.09.pdf

Cellular Network Challenges

- Network IP address varies (assigned “private” IP addresses)
  - ESPs can register their addresses with a public DDNS service
- No incoming connections accepted
  - Even after the ESP's IP address is published

- Verizon, AT&T & T-Mobile can provide a public IP address that accepts connections
  - By special arrangement for “business customers” only.
  - WHOI has public addresses from AT&T for their deployments in the Gulf of Maine
    - This wasn't an option when MBARI deployed cell comms first in New Zealand

- So, if ESPs on typical cellular networks must initiate all network connections...
  - How can a server accept incoming requests?
  - How can one fetch files when desired?
  - Or, log in to start an interactive session?

ESP Virtual Private Network

- ESPs maintain a VPN connection to a designated shore server
  - This VPN carries all traffic between the ESP and shore
    - Makes the ESPs look like they are on the same LAN segment
  - Almost all cellular carriers now allow VPNs
    - They are very common among corporate users

- All traffic within the ESP VPN is encrypted
  - via Microsoft's PPTP (Point-to-Point Tunneling Protocol)
    - Supported by all mainstream operating systems.
    - Hackable, but still very difficult to break into.
  - Insecure protocols within it are protected
    - like telnet and FTP

- VPNs may also be used to jump network firewalls in wired networks

MBARI's ESP Shore Server

- ESP Shore Servers
  - accept VPN connections from deployed ESPs and users
  - Upload data from deployed ESPs (typically once an hour)
  - Make that data available publically
    - via FTP and HTTP
  - Forward Email from deployed ESPs
    - via a single gmail account, common to all
    - Emails are clear text from ESPs
      - but encrypted when forwarded to Google's servers.
  - Forward designated ssh ports directly to corresponding ESPs
    - So users can administer ESPs without having to join the VPN
  - All in a $100 commodity WiFi router
    - Running OpenWRT firmware (natch!)

Accessing ESPs inside their VPN

- An ESP deployed in shore server's VPN is only acessible from:
  - within that VPN
  - From the same LAN segment (in the same lab)

- Otherwise, all access must pass through the shore server
  - FTP and HTTP access is to a mirror of the data on the ESP
    - Much faster and conserves cell bandwidth
  - SSH access is via designated port numbers
    - This allows administrators to issue commands to the ESP without joining its VPN
    - Requires SSH be installed on your laptop or smart phone [standard on Macs and Linux]

- Example of establishing an ESP client session with ESPmack while deployed:

```
$  ssh -p 2003 esp@espshore.mbari.org      #port 2003 leads to ESPmack on the VPN
esp@ESPmack$  espclient  myName            #connect to the running mission
 myName:001->  showlog                        #the ESP client command prompt
```

Preparing Shore Stations for Deployment

- Each shore station uploads from ESPs serviced by it
  - The ESPs uploaded from are ~ftp/ESP*
  - Each ~ftp/ESP* directory is “seeded” with subdirs and files to upload:
    - Typically, just the subdirectory “esp” and the file “messages”
    - First, download any old data you want to keep from the server
    - Just before deployment, for each ESPname:

```
esp@...$  cd ~ftp
esp@/home/ftp$  rm  -rf  ESPname      #delete old data
esp@/home/ftp$  mkdir  ESPname        #create empty directory
esp@/home/ftp/ESPname$  >  messages  #seed with empty kernel log
esp@/home/ftp/ESPname$  mkdir esp    #and esp data directory
```

  - *Add following command **only** if you wish to automatically upload hires images*

```
esp@/home/ftp/ESPname$  mkdir esp/hires  #not normally used
```

Preparing ESPs for uploading to shore

- Each ESP's deployment data is based at /var/log
  - /var/log/messages (kernel messages) should be emptied
  - /var/log/esp should be emptied after archiving it elsewhere

```
root@ESPname # cd /var/log
root@ESPname #  > messages  #do not delete this file with rm!
```

    - If you do, reboot or:

```
# service syslog restart
```

  - As User esp:

```
esp@ESPname $  rm -rf  /var/log/esp/*   #deletes old deployment data!
```

- The ESP's Real-Time clock is not sync'd to network time
  - They drift a couple minutes a month, set them, as root user, with:

```
root@espName #  date  -s  HH:MM  #or  YYYY.MM.DD-HH:MM
root@espName #  hwclock  -uw      #RTC is kept in UTC
```

Starting (& Stopping) Hourly Uploads of ESPs from shore stations

- Each shore station uploads every hour from its ESPs
  - This process must be manually started after each reboot
- To start hourly uploads:

  esp@station $ start hourly upload
- To stop hourly uploads:

  esp@station $ stop hourly
- To upload a from a particular ESP immediately:

  esp@station $ upload *ESPname*
- To upload from all deployed ESPs immediately:

  esp@station $ upload