Concept of Operation (CONOPS)

Sparse Digital Node HF Network Connectivity Techniques

Discussion Points

2024/11/01-R4

Initial Conditions, Assumptions, and Definitions…

The primary goal of this Concept of Operations (CONOPS) presentation is to identify potential operational modes and methods that could be used in for digital message passing over large geographical regions with sparse stations coverage.

At the top level, developing a continental/regional scale ECOM plan is dominated by:

- Physics of ionospheric propagation
- Sparseness of participating operators/stations
- Not all stations are visible to each other
- Communication structures may be required to be maintained for long periods of time (days, weeks, …)

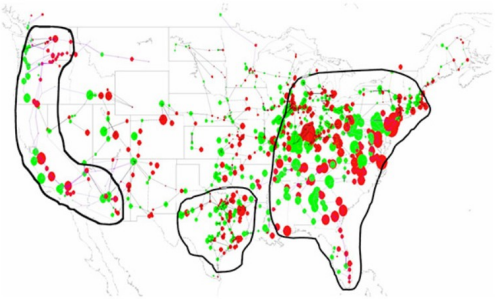
Initial Conditions, Assumptions, and Definitions…

EVENT SOURCE:

For example, a Carrington scale solar event has occurred disrupting traditional ECOM methods/channels.

EVENT IMPACTS:

Spatial: Significant portions of N. America have large scale power outages impacting traditional communication structures (ie. internet and cellular are out or intermittent). A large fraction of satellites are damaged.



Temporal: The traditional communications and power have no expected time for restoration. Long distance power lines have serious damage to transformers and may take months to restore.

Good EMP Reference:
https://theprepared.com/emergencies/guides/emp/

Initial Conditions, Assumptions, and Definitions…

Continental/Regional scale radio communications will usually require four ECOM modes:

- **Discovery Mode:**
  - How does one discover stations that are on-line available for message passing?
  - Where are they physically located?
  - How well are they receiving my station (Good copy, no loss of data packets,…)?

- **Monitor Mode:**
  - Over time, stations will be added and/or removed depending on availability.
  - Depending on frequency and time of day, reception will be variable among stations.
  - How do I determine the current local node members and availability for message passing.

- **Message Send Mode:**
  - For sparse HF nodes, message passing may require passing a message to other nodes.
  - A query must be made of local node members if they have access to other nodes that can pass the message to the specified destination or to a nearby node.

- **Message Receive Mode:**
  - Once a node member receives and delivers a message, confirmation of delivery needs to be transmitted back to the initiating node member.

Sparse Node HF Network Connectivity and Message Passing

Proposal for Implementing a *Command* and *Data* channel structure using Fldigi:

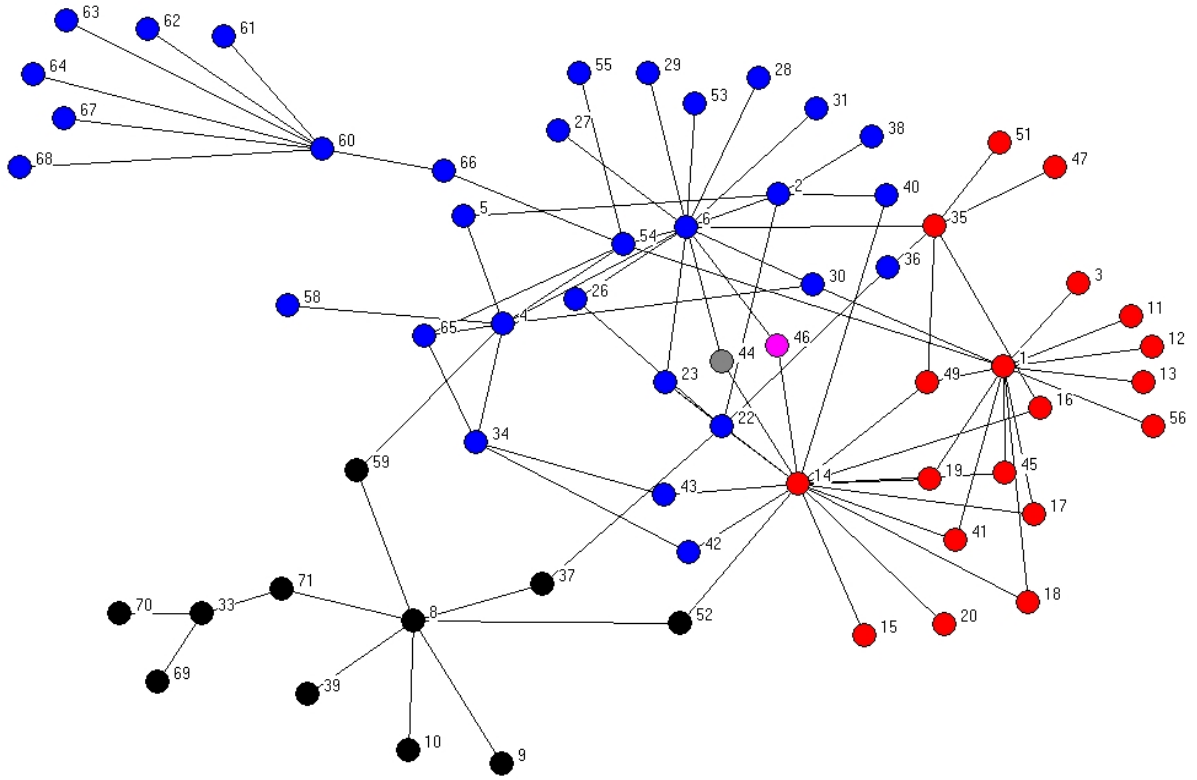
- The *Command* channel is used for (FSQ - TBR):
  - Node discovery
  - Short status messaging between node members:
    - I have traffic for xxx. Can anyone take this traffic?
    - I can take this traffic.
    - [Unless urgent, no other FSQ dialog is required.]
  - Informing others as to the D*ata* channel frequency, time, and destination to pass specific messages:
    - I WILL SEND TRAFFIC VIA FLAMP THIS FREQ, THOR22, @ +2K WF, WHEN YOU ARE READY TO COPY.
      de W1UVX

- The *Data* channel is used for (OLIVIA|THOR – FLAMP - TBR):
  - Sending formal error correctable digital messages
  - Receiving formal error correctable digital messages

Discovery Mode

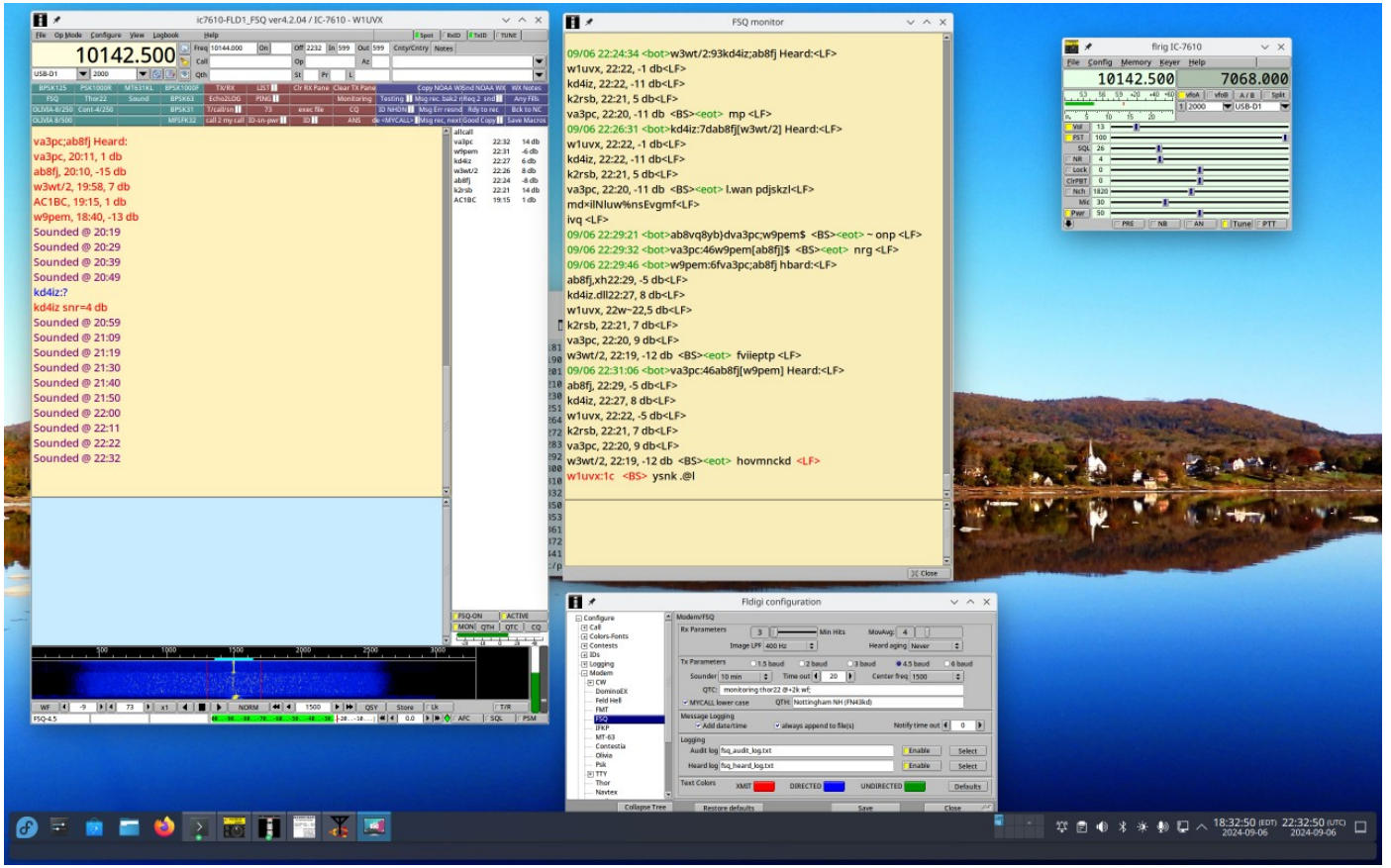
- How do we discover stations that define a local communications node?
- Where are they physically located?
- How well are they receiving my station?

Visibility to my node/mesh members is all I know – No further information is known about any other nodes. Every station has a time dependent node member list.



Discovery Mode Using Fldigi/FSQ

- Visibility to my node/mesh members is all I know.
- No further information is known about any other nodes.
- FSQ monitoring provides mode members, time, and signal strength.
- Short messages may be exchanged between members.



Discovery Mode Using Fldigi/FSQ

- At a specified time – (TBR) first 15 min every even hour, login and monitor the FSQ Command channel.
- In this example, we use FSQ mode for the command mode. Other modes could be used, however FSQ has a number of built in features that enhance net discovery.
- The FSQ heard list gives us a listing of node members, check in time, and signal strength.
- FSQ provides messaging to all or to specific members.
- Depending on the propagation, connectivity to individual members is dynamic. Stations may drop out or fade over time.
- Anyone with a S/n ~> 1 or 2 has a good chance to receive (or forward if needed) a message closer to the destination. Not that much different from NTS traffic handling.
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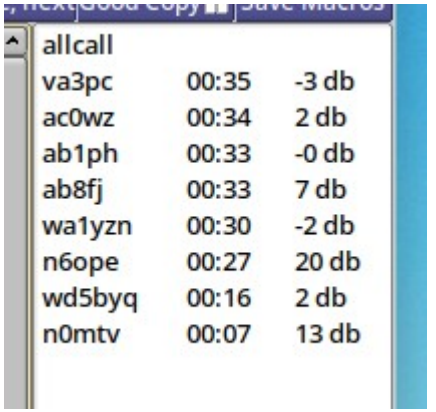
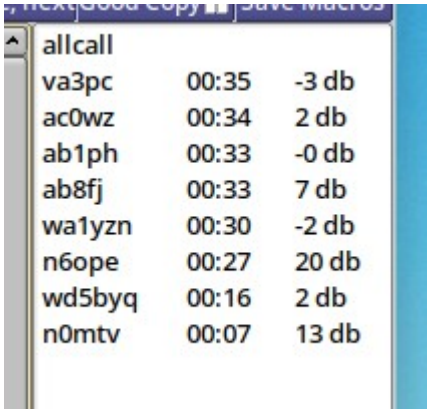


Discovery Mode Using Fldigi/FSQ

- During the discovery time, operators would sound every 5-10 min. That would give enough statistics for each operator to identify who is in their local node. At the end of the discovery period, anyone with traffic would do an all call to their local node members and look for a response to take and forward the traffic.

- Each station will have different members and corresponding physical locations. Some will have strong overlaps others will not. In the worst case, you may have two or more receiving stations attempting to pass the traffic to the recipient. (Not altogether bad especially when operating a sparse mesh net.)

- During discovery, other than 1 or 2 soundings, no one should be sending any messages or probing s/n's, etc. If the LO has traffic, the Local Operator (LO) will send a message to allcall. It will be up to the Distant Operator (DO) to determine if they can 1)take the traffic and/or 2) are potentially getting closer to the deliver location. At the end of the discovery if no one has any traffic to send/receive, the operator can QSY back to their local/home net monitoring.



Discovery Mode Using Fldigi/FSQ

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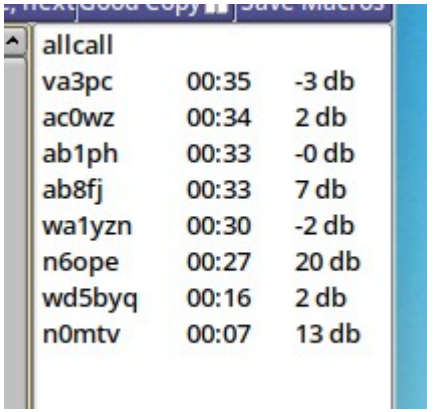

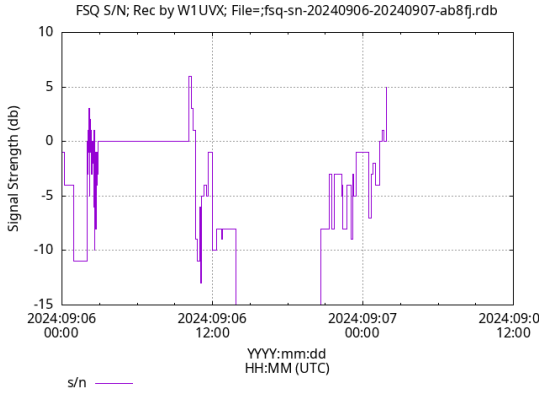

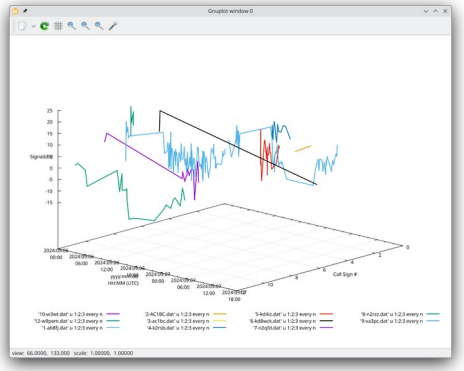

Message Send Mode Mode

- When a message is received by an operator from a local/regional served agency:
- The local operator (LO) sends an FSQ ‘allcall’ message to node members asking who can take and/or pass the traffic.

> I HAVE [ROUTINE|PRIORITY|URGENT] TRAFFIC VIA FLAMP:
> TIME: 2024/11/01 14:49Z
> FOR: DENVER CO EOC/FEMA
> FROM: NH STATE EOC
>
> CAN ANYONE TAKE THIS TRAFFIC?
> de W1UVX
>

- Distant Operator(s) acknowledges that they can take the message and deliver it directly or can pass it on to another physically closer node member.
- LO informs DO that the message will be send over a data channel (mode,freq,offset, and time) via flamp.
- At the scheduled time, LO sends the flamp message via data channel and waits for block fill requests from DO.
- DO acknowledges receipt and delivers the messages to destination or forwards the transmission request to another DO mode member.

Command and Data windows using FSQ and Thor22|Olivia

Fldigi Data window (Thor|Olivia|...)

Fldigi Command window (FSQ)