Concept of Operation (CONOPS)

Sparse Digital Node HF Network Connectivity Techniques Part 2

Discussion Points

2025/02/20 – R2.13

Initial Conditions, Assumptions, and Definitions…

Acknowledgments: Many people have contributed to this presentation. Thanks to all of the members of the FSQCall groups.io for their valued comments and contributions. And especially Ted AB8FJ, Sara N6OPE, Scott W3WT, and Bruce WA1YZN for their many suggestions.

The primary goal of this Concept of Operations (CONOPS) Part 2 presentation is to further detail 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, the success of a continental/regional scale emergency radio based communications system will be dominated in part by:

- The physics and constraints of ionospheric propagation
- The sparseness of participating operators/stations
- Communication structures may be required to be maintained for long periods of time (days, weeks, …)

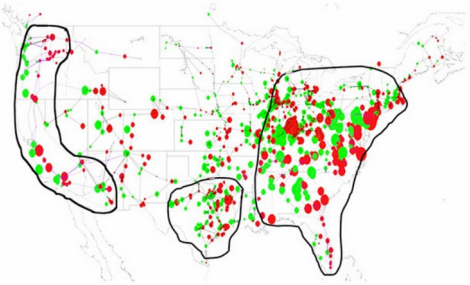
Initial Conditions, Assumptions, and Definitions…

EVENT SOURCE:

For example, if a Carrington scale solar event occurred, this has the potential to disrupting traditional ECOM methods/channels.

EVENT IMPACTS:

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



Temporal: The traditional communications and power systems could have significant long times for restoration. Long distance power lines have serious damage to transformers and may take months to restore.

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/Monitor 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,…)?
  - 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.

- **Obtain Served Agency Input**

- **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

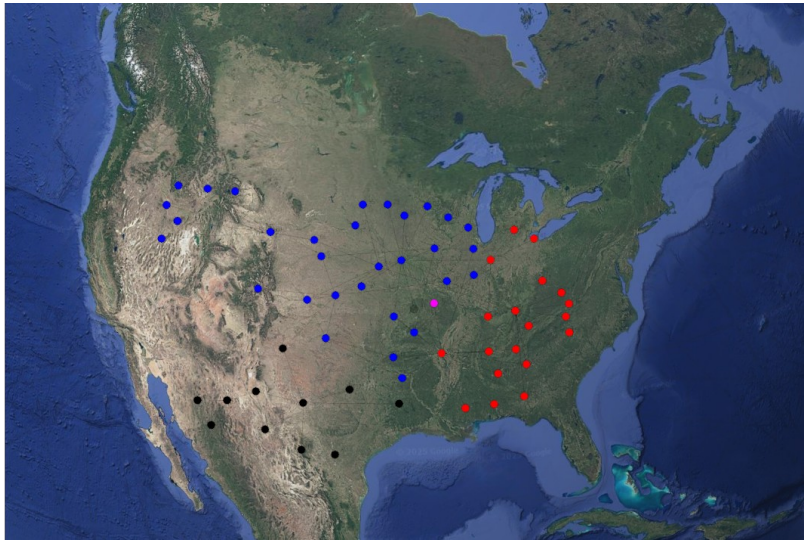
Propose Implementing a *Command* and *Data* dual digital channel structure using Fldigi:

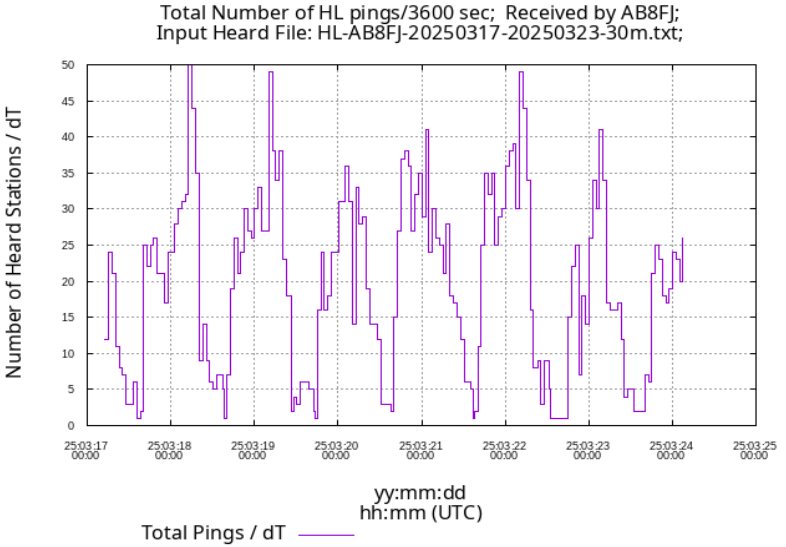
- The FSQ *Command* channel is used for:
  - Node discovery
  - Short status messaging between node members:
    - I have traffic for xxx. Can anyone take this traffic?
    - I can take this traffic.
    - [Unless urgent, no other FSQ dialog is required.]
  - Informing others as to the D*ata* channel frequency, waterfall offset, time, mode, and destination to pass specific messages:
    - I WILL SEND TRAFFIC VIA FLAMP THIS FREQ, THOR25, @ +2K WF, WHEN YOU ARE READY TO COPY.
      de W1UVX

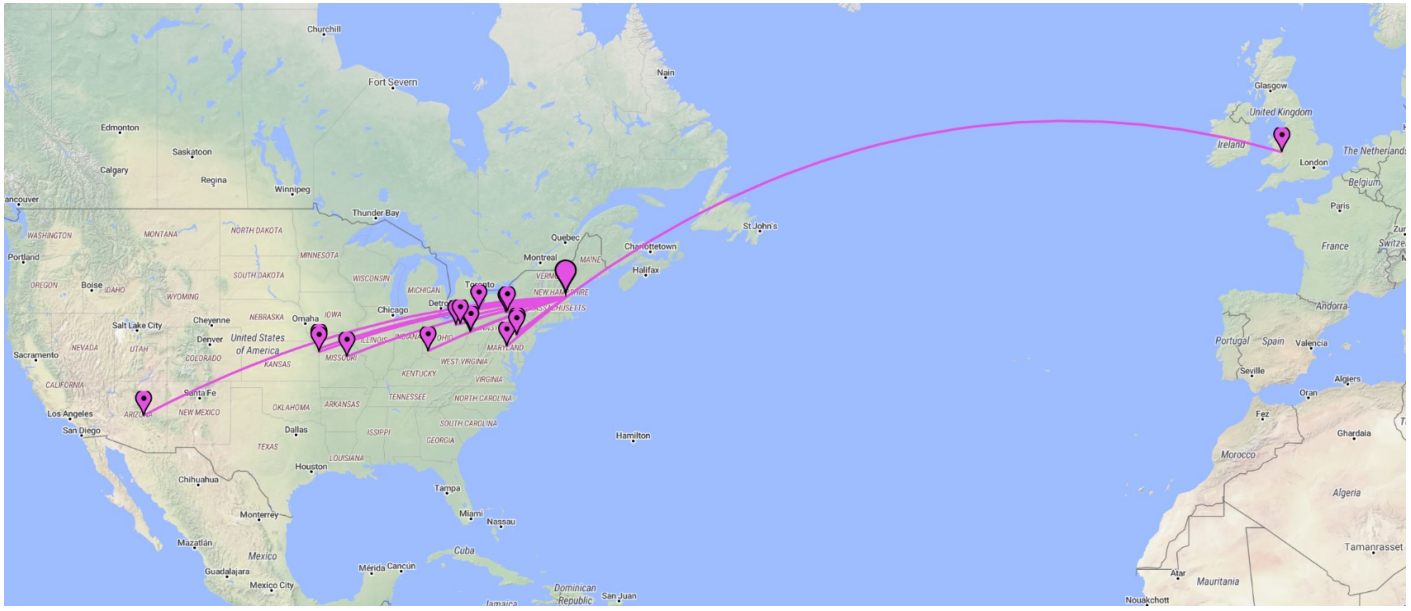
- The *Data* channel is used for (OLIVIA|THOR + FLAMP):
  - Sending formal error correctable digital messages
  - Receiving formal error correctable digital messages

Discovery Mode (FSQ)

Node Connectivity Map Example

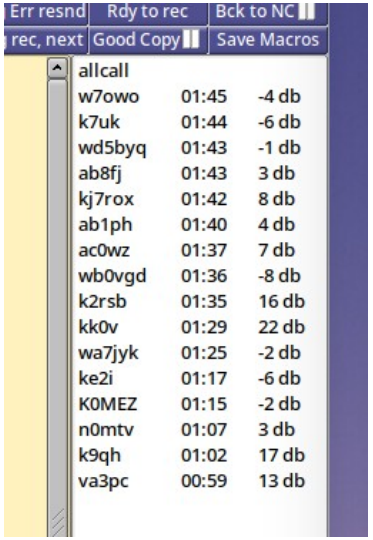




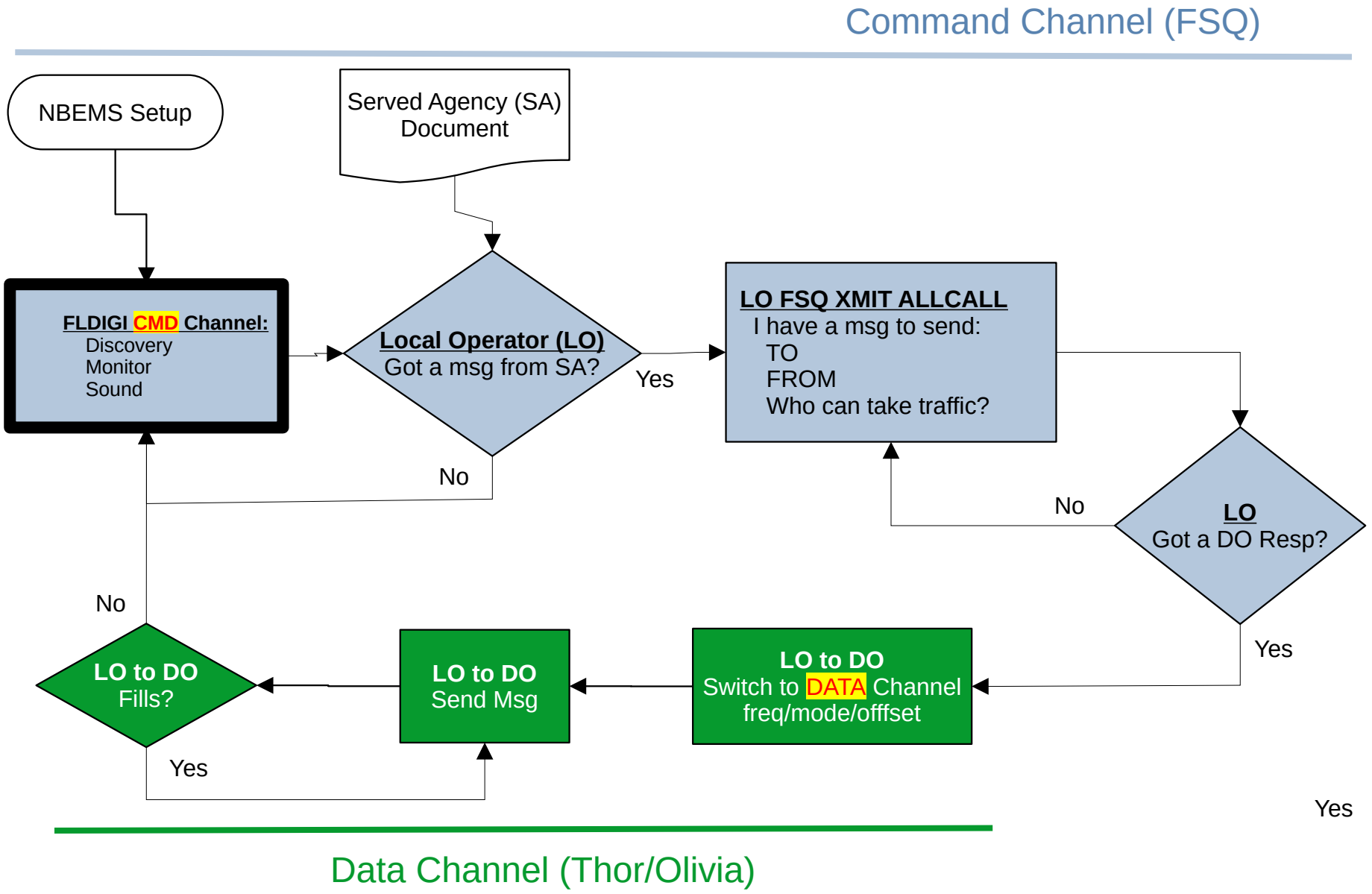


FSQ Node Connectivity Map Example
Stations heard by W1UVX

FSQ Heard List Example



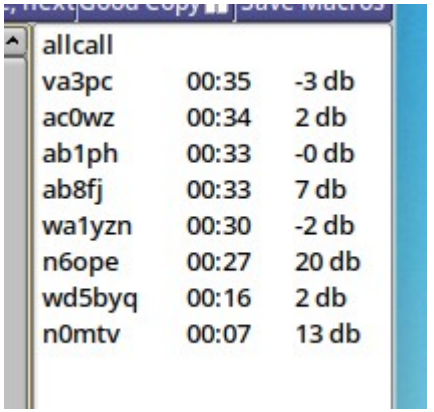
Flow Chart. Details to Follow...



Discovery Mode Using Fldigi/FSQ

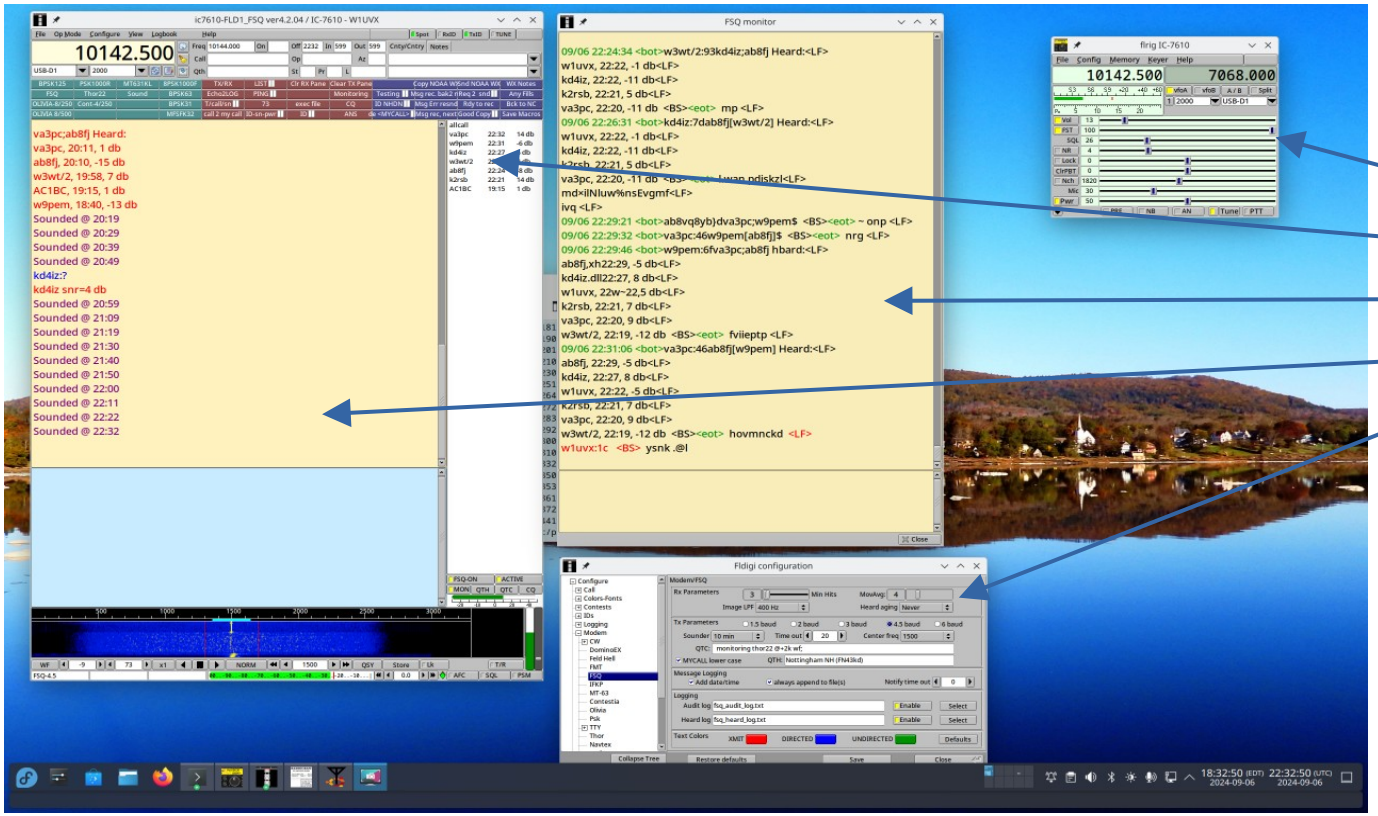
- In this example, at a specified time first 15 min every even hour, login and monitor the FSQ Command channel for traffic.
- During this monitoring time, your 'heard list' will populate.
- These are the stations of your local network.
- In this example, we use FSQ mode for the command mode. Other modes could be used, however FSQ has a number of built in features that enhance node member discovery.
- The FSQ heard list gives us a listing of node members, check in time, and signal strength.
- FSQ provides simple 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.
- The Local Operator (LO) will stay in the discovery mode until a message is received from a served agency request to send a message.
- FSQ provides file transfer and simple 'mailbox' functions.

FSQ Heard List Example



Discovery Mode Using Fldigi/FSQ

- Visibility to my node/mesh members is all I know.
- No further information is known about any other distant nodes.
- FSQ monitoring provides local mode members, acquisition time, and signal strength.
- Short messages *may* be exchanged between members, but not required.
- While in the Discovery mode, a NCS is not required.



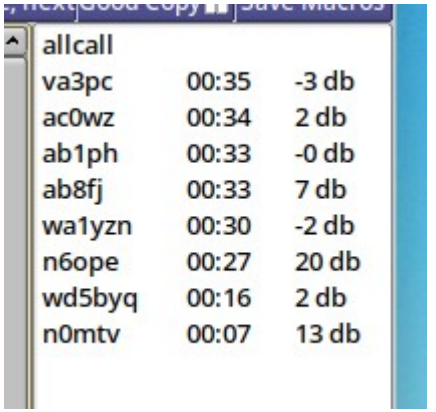
Discovery Mode Using Fldigi/FSQ

- During the discovery time, operators would sound every 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 ‘allcall’ to their local node members and look for a response to take and forward the traffic.

- Each station will have different node 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 delivery 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.

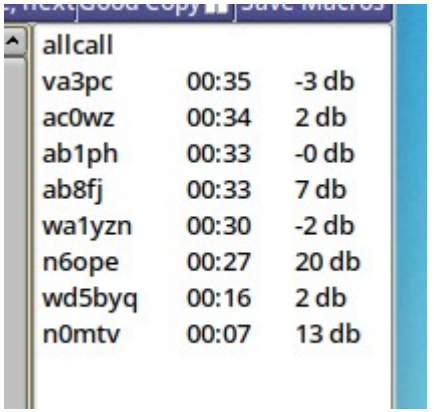
FSQ Heard List Example



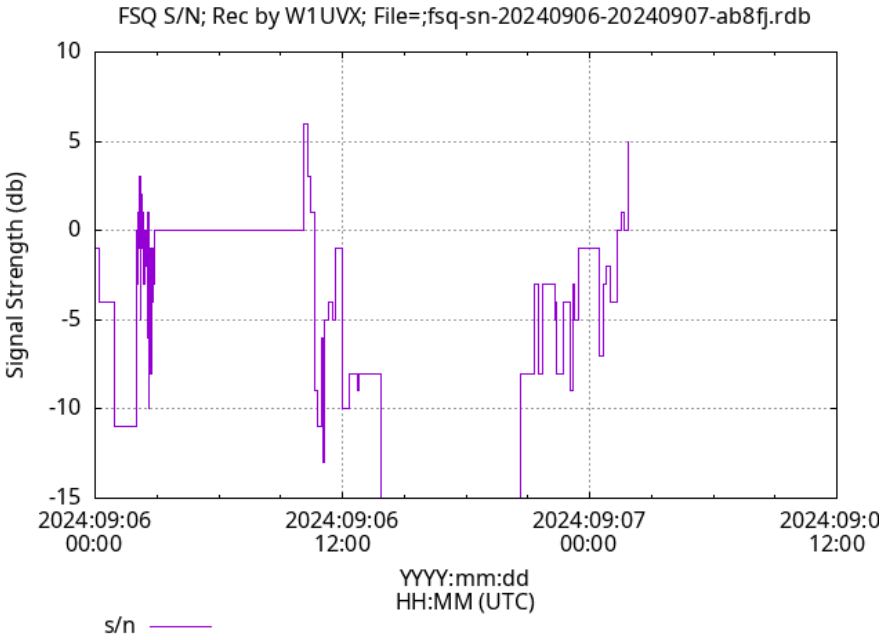
Discovery Mode Using Fldigi/FSQ

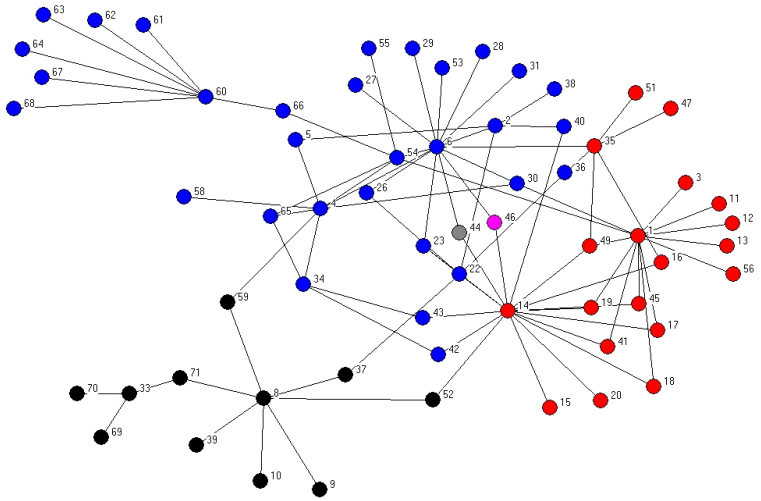
- The FSQ heard list gives us a listing of node members, check in time, and signal strength.
- FSQ provides messaging to all or to specific members.
- Connectivity to individual members is *dynamic*. Stations may drop out due to operator activities or fade over time as a function of band conditions.

FSQ Heard List Example



FSQ S/N vs time on 80m





Message Send Mode

When a message is received from a local/regional served agency:

- The local operator (LO) sends an FSQ ‘allcall’ command 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
>
```

- A Distant Operator(s) (DO) acknowledges that they can take the message and deliver it directly or can pass it on to another physically closer node member.
- At this point, all interactions are between the LO and the DO. Not everyone on the net needs to copy or acknowledge traffic.
- The LO and DO negotiate the data channel specifics, time, frequency, mode, and offset to exchange the flamp message.
- At the scheduled time, LO and DO change frequency/mode/offset and sends the flamp message via data channel and waits for block fill requests from DO.
- Via flamp, the DO acknowledges receipt and delivers the messages to destination or forwards the transmission request to another DO mode member. At the end of the exchange, the DO and LO return to monitoring the command channel.

Message Send/Receive Mode Exchange Example

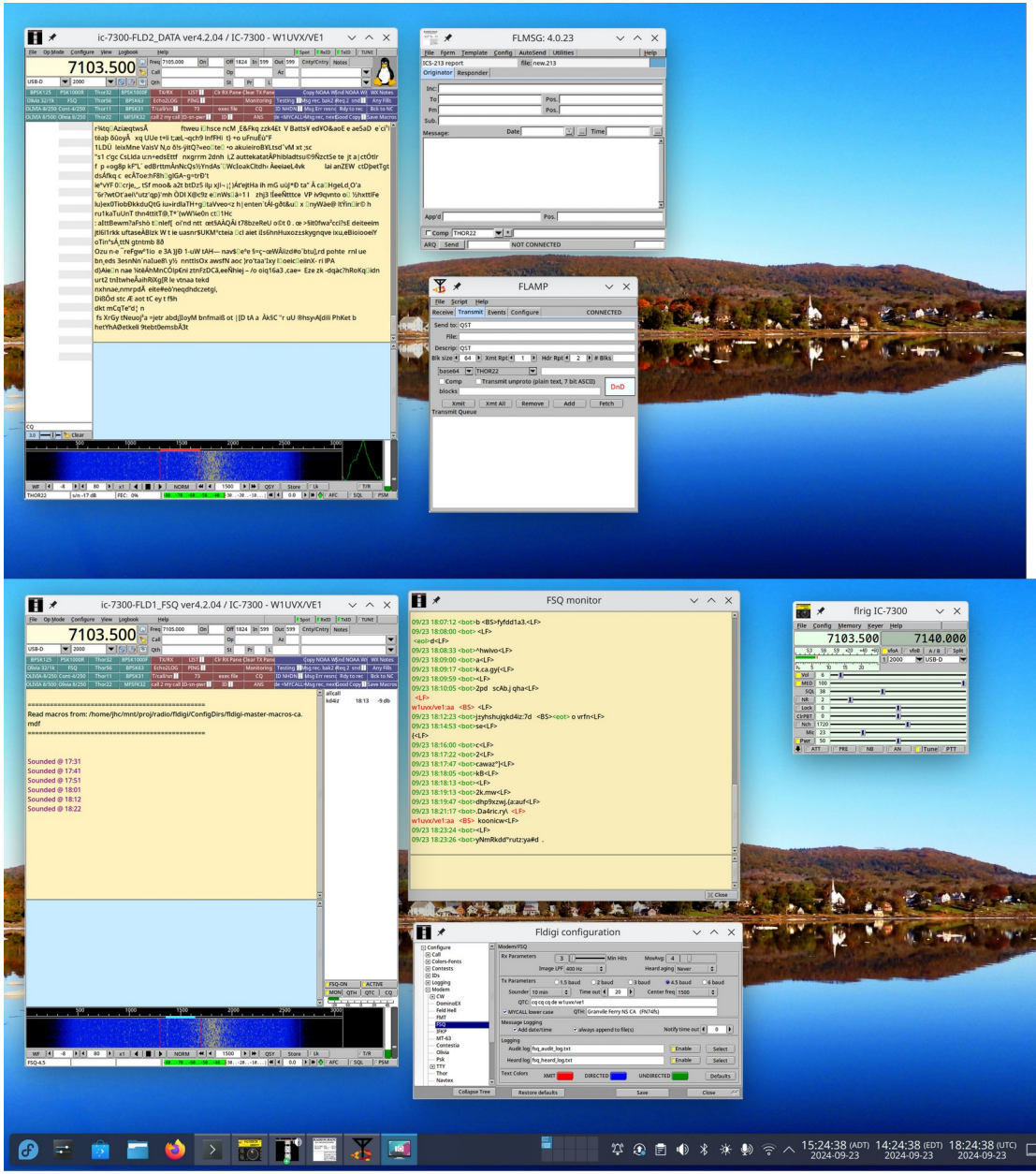
Operation		Local Operator (LO) Action	Distant Operator (DO) Response	Channel/Comment
Initiate a request to send traffic		REQUEST TO SEND PRIORITY TRAFFIC TO: DENVER CO EOC/FEMA FROM: NH STATE EOC @ <ZDT> de LO_CALLSIGN	LO_CALLSIGN. I CAN TAKE YOUR TRAFFIC. de DO_CALLSIGN	**COMMAND Channel**
LO and DO negotiate the traffic exchange details.		I have a FLAMP 7 blocks message. I will send on the data channel 3582, @ 2k wf, thor32 at 15:45 UTC. de LO_CALLSIGN	Ack de DO_CALLSIGN	**COMMAND Channel**
LO and DO change from COMMAND Channel to DATA Channel				
At specified time, freq, LO queries DO receive status.		DO_CALLSIGN are you ready to copy traffic? de LO_CALLSIGN	Ready to copy. de DO_CALLSIGN	**DATA Channel** **After confirming ready-to-copy, all further exchanges and confirmations should be done via flamp.**
LO Traffic is sent via FLAMP		Sends FLAMP traffic via DATA channel.		**DATA Channel**
LO Checks for requested FLAMP block fills.			Using the FLAMP 'REPORT' function, DO reports missing message blocks (if any).	**DATA Channel**
DO acknowledges traffic exchange is complet and returning to Command Channel			Back to Cmd channel. (BTU) de DO_CALLSIGN	**DATA Channel**
After exchange, LO and DO return to Command Channel. If exchange fails, LO makes another request to transmit traffic on the Command Channel				**COMMAND Channel**

Command and Data windows using FSQ and Thor22|Olivia

Example:
Two fldigi instances connected to one flrig. Each operating on a Different waterfall offset.

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

Fldigi Command window (FSQ)



Appendix – Useful Macros

Macro Name		MACRO
Req2Snd-1		***THIS IS A TEST*** REQUEST TO SEND [*TEST*|ROUTINE|PRIORITY|URGENT] TRAFFIC TO: DENVER CO EOC/FEMA FROM: NH STATE EOC @ <ZDT> de <MYCALL> <RX>\n
Req2Snd-2		*** THIS IS A TEST *** I HAVE [ROUTINE|PRIORITY|URGENT] TRAFFIC VIA FLAMP: FOR: DENVER CO EOC/FEMA FROM: NH STATE EOC @ <ZDT> CAN ANYONE TAKE THIS TRAFFIC? de <MYCALL> <RX>
Rdy 2 Snd-1		READY TO SEND 1 FLAMP VIA <MODE>/<FREQ> - STANDBY de <MYCALL>\n <RX>
Any Fills?		ANY FILLS OR REPEATS? de <MYCALL> <RX>
Bck 2 NCS		BACK TO NCS de <MYCALL> <RX>