



VHF/UHF DX

Using Airplane Scatter

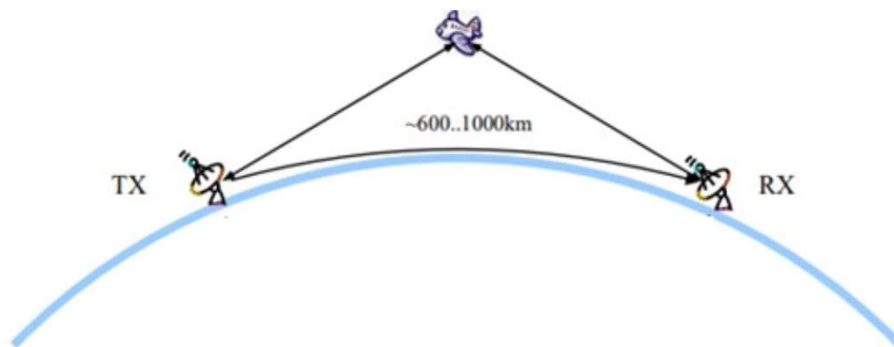
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Airplane Scatter ?

- RF reflection from Airplanes known about since 1930 (radar)
- Amateur Radio usage dates from ~ 1967
- Aircraft must be:
 - line of sight (radio not visual)
 - In path between Rx and Tx
- Can work DX (up to ~1000 km)
- Hear an example
- 2013 10 05 1 2G G3OHM D
 - (start half way, see how more readable G4OHM is as plane passes)
- <https://www.youtube.com/watch?v=g6IFVdu031s>





Features

- Can work 'DX' in flat conditions
- Very predictable
 - We know where planes are, where they're going etc.
- Works on VHF bands 6m and upwards
- Doesn't need high power (but easier if you have it)
- Doesn't need high gain antennas (but easier if you have)
- Quite often used without realising
- 'Window' can be short (few mins) to long depending on flight path



dB gain from Aircraft Scatter

- At mid-point of path $\sim 30\text{dB}$
- Outside of mid-point $0 \sim 20\text{dB}$
- Sometimes you only need a few dB to get above the noise
- Perhaps you can hear them, but they cannot hear you
 - You are QRP they are not etc.
 - 3dB can make the difference between being heard or not.
 - Commonly I can hear other station without aircraft but cant hear me



Doppler shift etc.

- The signal reflected back from an aircraft will have a doppler shift based on the speed of the aircraft.
- The forward reflected signal is shifted 'back' thereby reversing it.
- So a plane at mid-point has same + and – shift, so cancels out.
- But as the plane departs the mid point, one is greater than the other so a shift is notable.
- Information from 'the web' suggests planes have to be mid-way to be effective, but I (and others) can testify otherwise.



The Mathematics

- $L = 153 + 10 \log \left(\frac{((R_t)^2)(R_r)^2}{(\lambda^2)S} \right)$
 - where L = total loss (in dB)
 - R_t = distance from transmitter to reflector in km
 - R_r = distance from receiver to reflector in km
 - λ = wavelength in meters
 - S = radar cross section of the aircraft in meters
- In summary:
 - Bigger planes bigger reflectors (Lear Jet=2m² Boeing 747=63m² etc.)
 - Shorter wavelengths better than long (2m better than 6m)



Line of Sight



- Normal Distance to Horizon = $4.12 * \sqrt{h}$ (antenna height)
 - 30m antenna = 22.6 Km horizon
- An aircraft flying at 10,000m will extend the horizon to 400 km
 - Giving a potential QSO distance of 800 km



Reflected Beamwidth

- Reflected signal is better at shorter wavelengths
 - (From the formula)
- But Reflected beamwidth gets smaller at :
 - Shorter wavelengths
 - Larger reflecting objects (planes)
- So....
 - Bigger planes reflect more but in a narrower beam
 - Higher frequencies reflect more but in a narrower beam
 - Our plane has to be well located mid-way between Tx and Rx stations



Never mind the maths

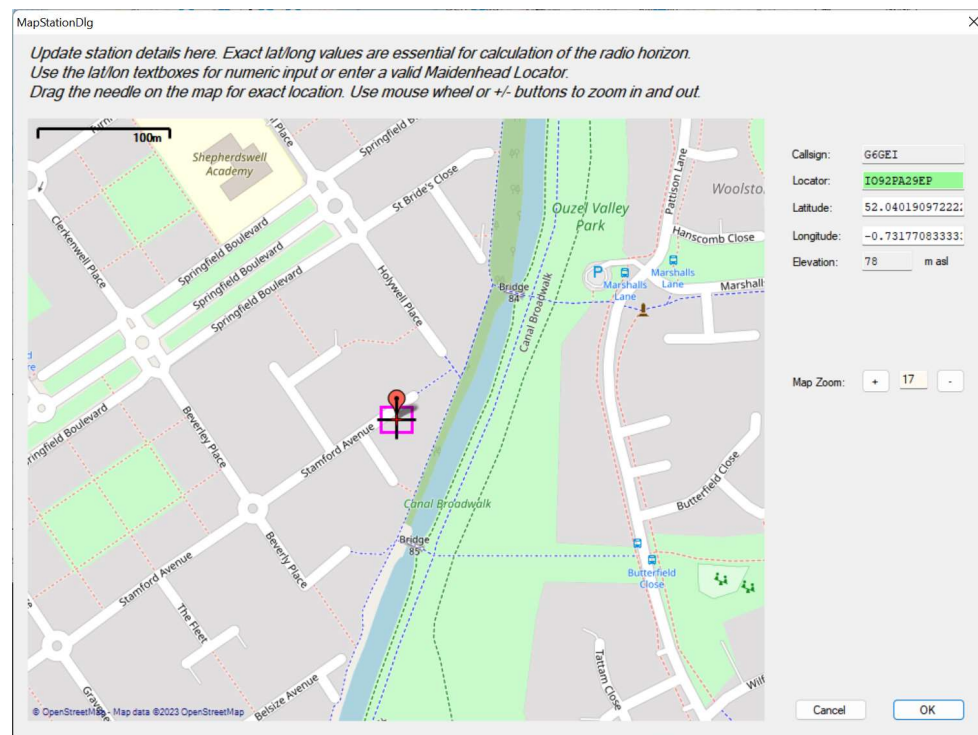
- Fortunately computers can calculate all this for us
- Some very clever software by DL2ALF called AirScout
 - Calculates the reflected signal levels
 - Gives indication of 'best chance'
 - Accounts for:
 - Power of TX station
 - Gain of TX / RX Station Antennas
 - Height / Location of TX/RX Stations
 - Geography between stations
 - Location / Size / Altitude / Direction of planes





Precise location important

- Needs your Maidenhead Grid Locator to 10 places
 - E.g. IO92PA29EP
 - Which side of the hill are you, tall objects blocking take-off etc.
- Has a tool built in to determine
 - Just click your operating location
- Updates to a central DB
 - Used for calculating between 2 stations





Station Information

<i>My QRV</i>		<i>Band</i>
Antenna Height:	<input type="text" value="10"/> m	<div>▲</div>
Antenna Gain:	<input type="text" value="10"/> dbD	<div>144M</div>
Power:	<input type="text" value="100"/> W	<div>▼</div>
Last Updated: 2020-04-18 08:06:21		

- For each band you're going to use:
 - Height of the Antenna
 - Gain of the Antenna
 - Power to be used on TX
- Critical if you want 'real' likelihood of QSO to other stations



Ground Maps

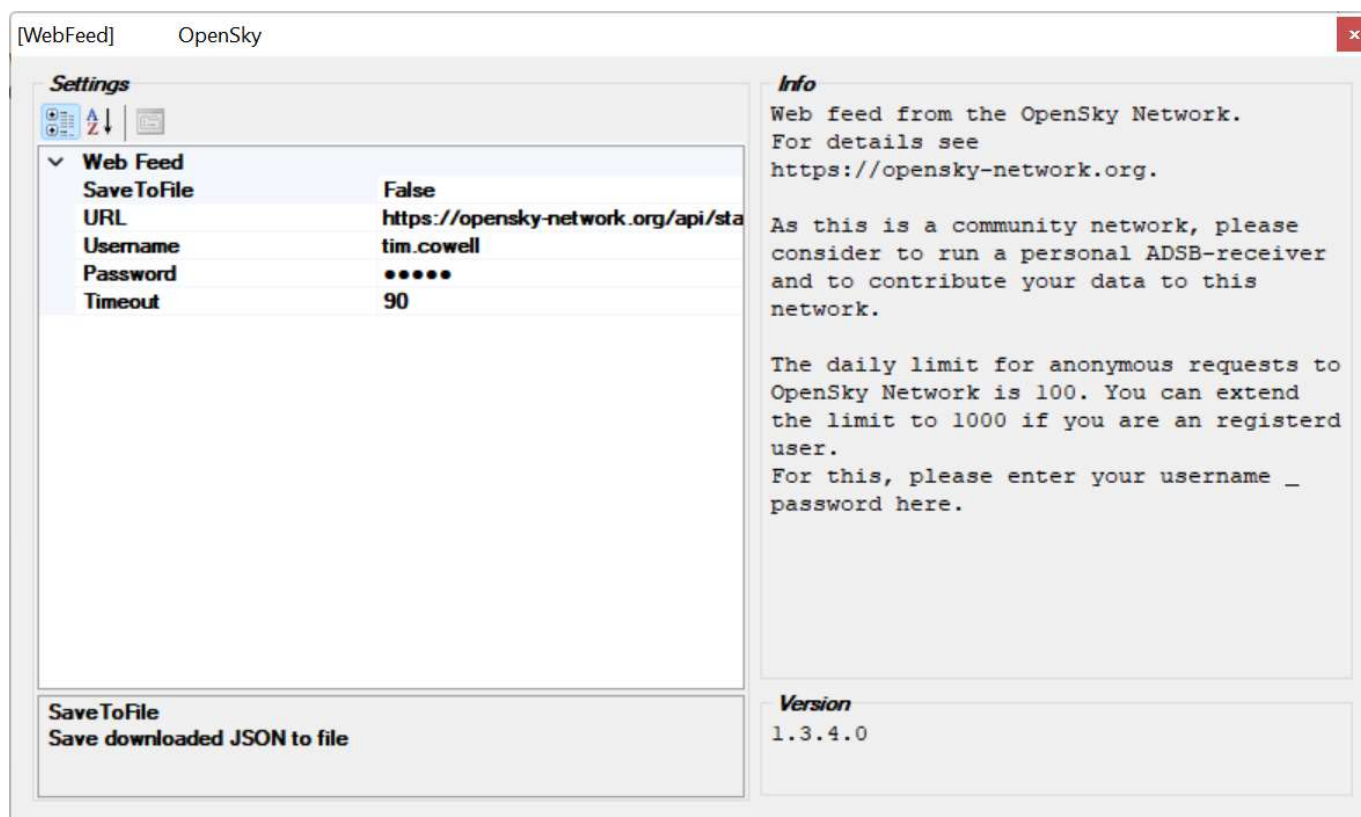
- Choice of resolution for ground contour mapping
 - GLOBE 1km square elevation data
 - SRTM3 90m square elevation data
 - SRTM1 30m square elevation data
- Finer resolution = more accurate, better precision, slower
 - Suggest SRTM3 for most
 - Keep map size small (limited to 1000 km distance)
- PC Specs
 - CPU intensive with finer resolution – need high spec PC / Laptop
 - Airscout eats battery life on Laptops when operating Portable



Planes Web Feed

Gets real time plane data from the Internet

- Suggest using OpenSky
- Create an OpenSky account
- Limited # lookups / day
- Become an OpenSky data feeder for more access





Network Server

- Allows AirScout to be Resource used by other apps
 - Logging / Messaging apps (more later)

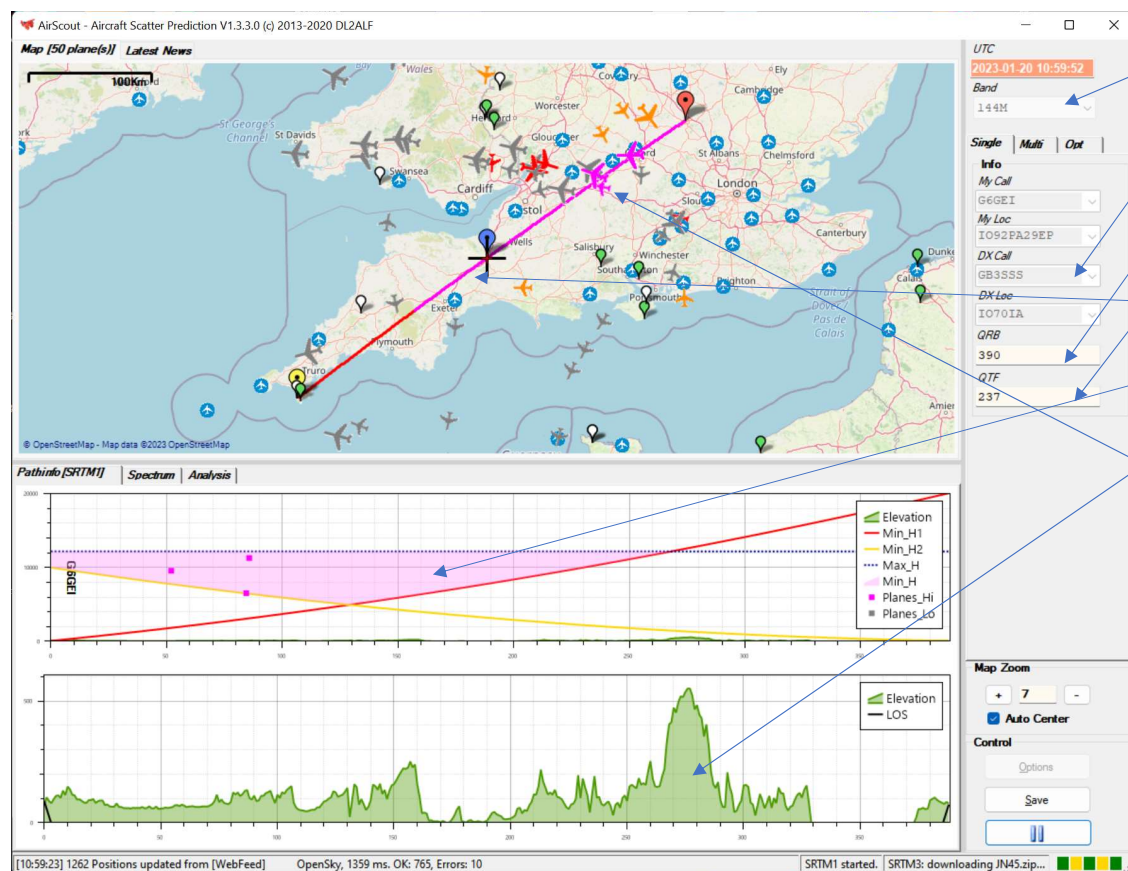
Activate Server
☒ Activate Network Server
AirScout can work as a server in a network.
UDP Server:
You can ask for a path calculation between two stations and AirScout will return the planes near path and their portential for a reflection.
HTTP Server:
You can ask for latest plane positions via simple http-request (e.g. from a web browser. The result is delivered as a JSON file which can used to run own services and calculations.
See documentation for further details.

UDP Server Settings
AirScout UDP Server Name:
AirScout UDP Server Port:

HTTP Server Settings
AirScout HTTP Server Port:



AirScout in Action

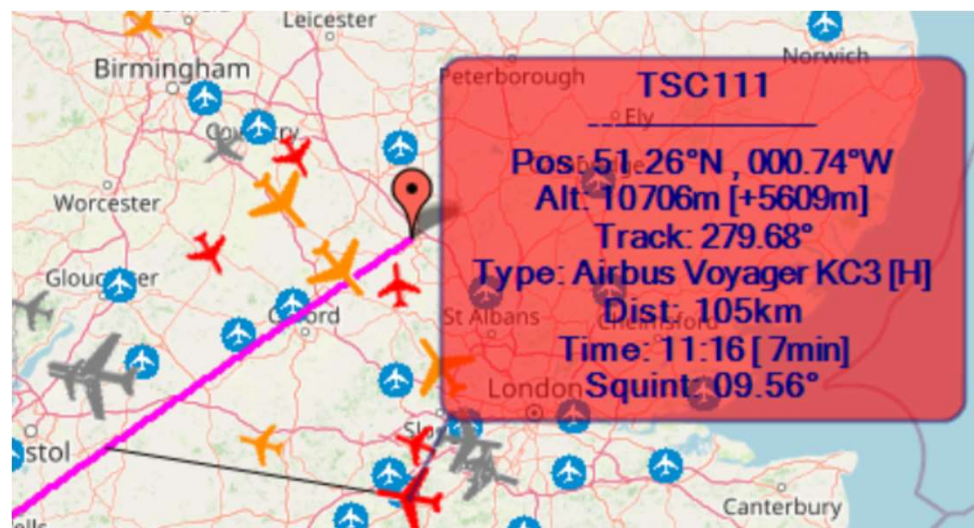


- The operating band
- Callsign of remote station
- The distance to station
- The bearing to station
- Path to target
- Hot section
- Ground elevation
- Coloured planes - potential



When will there be a plane?

- Click on a coloured plane
- Displays
 - Plane flight number
 - Type
 - Distance to intercept
 - Time to intercept (7 min)
 - Squint – bigger the better



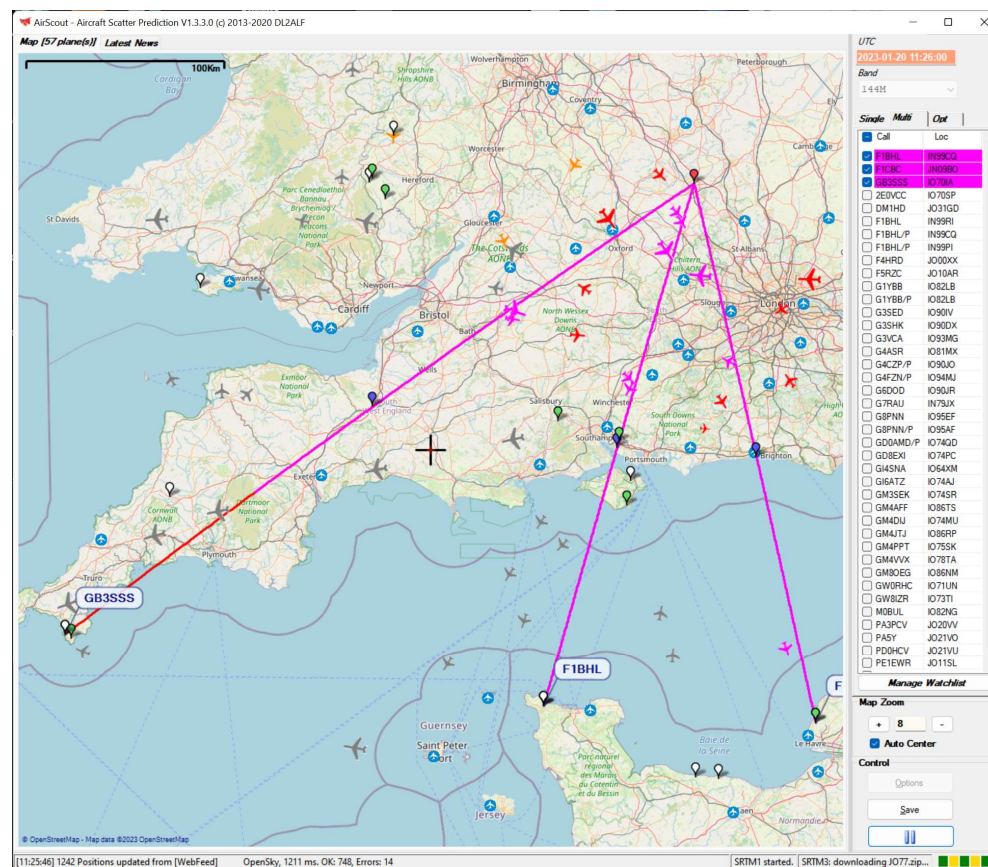
Ideally find a plane travelling 'along' the path, not across

Will give a longer contact time / opportunity

'Grey' planes are outside of the 'hot spot' (wrong altitude)



- Watch stations you 'expect' to be able to work.
- When viable the entry will highlight.
- Tracking more targets is CPU intensive





Is the other station trying also?

- AirScatter requires BOTH stations to be pointing at each other
- How best to achieve that?
- Use a messaging app, or better still one integrated with AirScout
- ON4KST is the Answer
 - Also used to arrange Schedules for EME, Meteor Scatter etc.



KST – online Messaging for Hams ON4KST

- www.on4kst.com
- Chats for 50/70 Mhz, 2m/70cm, Microwave (23cm and above)
- You need to register, but it's free.
- You can list who is logged into each chat.
- Where they are (Maidenhead grid square, e.g. IO92RA)
- Message them to ask to arrange a qso.
- Used for generic DX (E's, meteor scatter, eme, planes etc.)

Please login (ON4KST chat):

Members log in here:

Callsign:

g6gei

Password:

.....

Select chat:

Select the chat

Select the chat

28 MHz

50/70 MHz

50 MHz IARU Region 2

50 MHz IARU Region 3

144/432 MHz

144/432 MHz IARU R 2

144/432 MHz IARU R 3

Microwave

kHz (2000-630m)

Low Band (160-40m)

Warc (30,17,12m)

EME (all bands/modes)



Minos – KST Client

- Minos is Contest logging software
- But Comes with a great KST app, integrates with AirScout !
- <https://minos.sourceforge.net/download.html>
- Can run the KST Client without running rest of Minos
- Benefits:
 - Integrates with AirScout – will see this shortly.
 - For each KST user, lists the likelihood of getting an AS qso
 - Sends list of KST users to AirScout so can watch multiples at once
 - Tells you time until possible contact for each user
 - Watch others arrange AS QSOs and piggy-back



KST Client App

Download the Minos Client from <https://minos.sourceforge.net/download.html>

Install the client software, typically to c:\minos

If you're going to use Minso for contest logging, then that's a different discussion.

To use just for the KST client, browse to c:\minos\bin

Run the MqtKSTClient.exe



First time you run it will ask to configure:

Make sure the AirScout settings match those made in AirScout.

You can change your First name, e.g. from Tim to:

Tim 6m (confirm which band you're working)

Tim 6m JT6M (tell others you can use JT6M)

Tim 6m 50.225 (self spotting)

The screenshot shows the 'Minos KST Client Configuration' dialog box. It has two main sections: 'ON4KST' and 'AirScout'. In the 'ON4KST' section, 'Callsign' is 'G6GEI', 'Locator' is 'IO92PA', 'Password' is empty, 'First Name' is 'Tim', and 'Automatically connect on load' is checked. In the 'AirScout' section, 'Server Name' is 'AS', 'My Name' is 'Minos', 'Server UDP Port' is '9872', 'Server timeout' is '10', 'Minimum distance' is '300', and 'Maximum distance' is '1000'. There are 'Cancel' and 'Ok' buttons at the bottom.

Section	Field	Value
ON4KST	Callsign	G6GEI
	Locator	IO92PA
	Password	
	First Name	Tim
	Automatically connect on load	<input checked="" type="checkbox"/>
AirScout	Server Name	AS
	My Name	Minos
	Server UDP Port	9872
	Server timeout	10
	Minimum distance	300
	Maximum distance	1000



KST Client

List of who's logged into KST.
Can filter if looking for
someone/somewhere

Chat history between users.
Again can filter to look for
someones chat..

AirScout data for currently
selected station

Your own chat history
(to/from you)

Where you enter/send a
message (meep)

Minos KST Client

Log In ☒ 50/70 MHz ☐ 144/432 MHz ☐ Microwave ☐ EME/JT65

User Filter

Chat	Callsign	Loc	Dist	Brg	AS
50/70 MHz	*HA8CE*	KN06EN	1638	103	>
50/70 MHz	*M0XVF*	IO94EQ	303	349	(1)
50/70 MHz	4X4DK	KM71JV	3633	114	>
50/70 MHz	9A2NA	JN65SH	1282	120	>
50/70 MHz	9A5CW	JN65XF	1313	119	>
50/70 MHz	9H1TX	JM75EL	2160	140	>
50/70 MHz	9Y4D	FK90GG	7131	253	>
50/70 MHz	AC4TO	EM70XL	6953	285	>
50/70 MHz	BA4SI	PM01HD	9153	48	>
50/70 MHz	CT1APE	IM59KL	1538	208	>
50/70 MHz	CT1EKY	IM58JP	1627	207	>
50/70 MHz	CT1FFU	IM59KK	1542	208	>
50/70 MHz	CU2JX	IM77ER	2505	240	>
50/70 MHz	CU2JX	IM77ER	2505	240	>

Max distance to show 99999

Flight Category Dist Pot Mins

Active chat ☒ 50/70 MHz

AS Band 50MHz ☒ AS Active

General message Callsign Message

Meep

Clear message

Configure Clear Messages

Set Away Disconnect Close

Message Filter

Chat	Time(Z)	Call	Name	Other Call	Text
50/70 MHz	14:18	NL8992	Anthonie swl4/6m		50313 now empty for last minutes,
50/70 MHz	14:19	NL8992	Anthonie swl4/6m		And again: 131830 -18 0.3 1027 ~
50/70 MHz	14:54	G4PLZ	Pete 6m->70cm		Big thunderstorm in N Sea raising r
50/70 MHz	14:55	OY1R	Regin		sa5acr, oh2fqv, m0ctp, zo4aal and
50/70 MHz	14:57	MM0BSM	Stu 6m only		Pete thing we have to get thunder s
50/70 MHz	14:59	G4IFX	Chris		CQing west 50.305 Q65-30A 1000
50/70 MHz	15:05	PA8KM	Harry		>>>> I also but on 700Hz: CQing
50/70 MHz	15:06	OY1R	Regin		i cannot do Q65 :-/
50/70 MHz	15:07	MM0BSM	Stu 6m only	OY1R	you need to use wsjtx for it Regin
50/70 MHz	15:10	SERVER	Message		Use the inline ON4KST-2 CLX DX d
50/70 MHz	15:15	OY1R	Regin		i cannot get it installed

Including G6GEI

Chat	Time(Z)	Call	Name	Other Call	Text
------	---------	------	------	------------	------



KST Client

Make sure you're logged into the correct KST 'Chat forum' for the band you're working.

If logged into multiples, make sure the active chat forum is the right one also.

Make sure the AS band is also the same, and that AS Active is ticked.



Minos KST Client

Log In



50/70 MHz



144/432 MHz



Microwave



EME/JT65

Active chat



50/70 MHz

AS Band

50MHz



AS Active



KST Client

You can click the column headings to sort in order, shown here clicking on the AS column will list stations in most likely workable via AS first. In this case PA3FVE.

The 4(7) indicates there are 4 planes currently viable, and a total of 7 planes in the near future.

You can filter (by callsign, grid square etc.)
Shown here I have filtered by PE

Note the AS column:

- > distance is too far for AS
- < distance is too close for AS

You can filter for a specific single callsign if want to.

Log In ☒ 50/70 MHz ☐ 144/432 MHz ☐ Microwave ☐ EME/JT65

User Filter X

Chat	Callsign	Loc	Dist	Brg	AS
50/70 MHz	PA3FVE	JO21XF	469	98	4(7)
50/70 MHz	DK9KX	JO30MX	549	99	3(7)
50/70 MHz	ON4IQ	JO20AR	360	112	2(9)
50/70 MHz	MM0AMW	IO75EJ	496	321	2(7)
50/70 MHz	PE5HV	JO21VM	451	95	2(6)

User Filter PE X

Chat	Callsign	Loc	Dist	Brg	AS
50/70 MHz	PE5HV	JO21VM	451	95	1(7)
50/70 MHz	PE1RLF	JO32CG	473	84	1(6)
50/70 MHz	PE1FBC	JO22IV	380	73	(6)
50/70 MHz	(SM5DWF)	JO99JU	1486	47	>
50/70 MHz	SM2CEW	KP15CR	1992	31	>
50/70 MHz	OG2M	KP21TD	1886	47	>
50/70 MHz	IZ8NVV	JN70JT	1716	130	>
50/70 MHz	CU2JX	HM77ER	2505	240	>
50/70 MHz	CT1EKY	IM58JP	1627	207	>
50/70 MHz	CT1APE	IM59KL	1538	208	>
50/70 MHz	G4PLZ	JO02PT	162	56	<



KST Client

Select a specific station in the list.

The stations AS statistics are updated in the panel below.

This example shows there is one flight currently viable, with a high potential (100), just 2km off the direct path.

There is another due in 3 minutes, but only a 50% potential of working.

And another in 6 mins, and two more slightly better ones in 9 and 17 mins.

Click the [Show me->user Path in AirScout] button.

AirScout will open to show the path details.

Chat	Callsign	Loc	Dist	Brg	AS
50/70 MHz	PE1RLF	JO32CG	473	84	3(6)
50/70 MHz	PE5HV	JO21VM	451	95	1(5)
50/70 MHz	PE1FBC	JO22IV	380	73	(4)
50/70 MHz	(SM5DWF)	JO99JU	1486	47	>
50/70 MHz	SM2CEW	KP15CR	1992	31	>
50/70 MHz	OG2M	KP21TD	1886	47	>
50/70 MHz	IZ8NVV	JN70JT	1716	130	>
50/70 MHz	CU2JX	HM77ER	2505	240	>
50/70 MHz	CT1EKY	IM58JP	1627	207	>
50/70 MHz	CT1APE	IM59KL	1538	208	>
50/70 MHz	G4PLZ	JO02PT	162	56	<

< >

Max distance to show

Flight	Category	Dist	Pot	Mins
BTI6BL	M	2	100	0
[unknown]	L	30	50	3
VLG710V	M	80	50	6
RYP7LD	M	116	75	9
AAR793	H	221	75	17

2021-05-09 14:32:14Z
G6GEI at IO92PA
to PE5HV at JO21VM

Show me->user
Path in AirScout

Show Message call->other
Path in AirScout

☐ Don't set filter
when user selected



KST - Meeping

We have a potential target/victim

But they need to know you want to try working them, so they can point at you.

General message	Callsign	Message
Meep	M0NYG	Hi Nigel, plane in 2min can we try ?

Including G6GEI

Chat	Time(Z)	Call	Name	Other Call	Text
50/70 MHz	15:59	G6GEI	Tim	M0NYG	Hi Nigel, plane in 2min can we try ?
50/70 MHz	16:01	M0NYG	Nigel	G6GEI	Sure I'm beaming your way now

Including G6GEI

Chat	Time(Z)	Call	Name	Other Call	Text
50/70 MHz	15:59	G6GEI	Tim	M0NYG	Hi Nigel, plane in 2min can we try ?
50/70 MHz	16:01	M0NYG	Nigel	G6GEI	Sure I'm beaming your way now
50/70 MHz	16:02	G6GEI	Tim	M0NYG	Got you.... thanks for QSO
50/70 MHz	16:03	M0NYG	Nigel	G6GEI	Great Tim Thanks for the QSO 73'S



KST - Meeping

- If using for contests DO NOT MEEP Locator or Serial Nos.
- But strangely IS OK to Meep Frequency (apparently not self spotting)
- Find a station using AS by filtering Message Filter for 'Plane' or 'AS'
- Piggy back someone else's sched
 - Watch others arrange a sched along same/close path as you.
 - If you hear the DX station, wait till their QSO over then call.
- Don't be afraid to ask. No one will say No. But you might have to wait.



Putting it all together

- It can be daunting.
- Practice hearing beacons using Planes.
- It doesn't always work.
- Feels great when it does ! (GM4AFF on 10W Aberdeen)
- Two planes better than one, three better than two ;)
- Planes along (not across) the path are better
- My failed attempt to work GI4SNA (play from abt 4:30)
 - Watch S3 increases to S7 when plane overhead
 - Couldn't hear me due to QRP issues with my station that night
 - <https://MKARS.Document-Safe.com/DMWeb/GI4SNA.mp4>
- You will learn what plane positions work best for you



References

- [Home - Homepage AirScout](http://www.airscout.eu) www.airscout.eu DL2ALF
- www.on4kst.com
- <https://minos.sourceforge.net/download.html>
- http://www.pa0ehg.com/144_beacons.htm
- <http://www.pa0ehg.com/planescatter.htm>