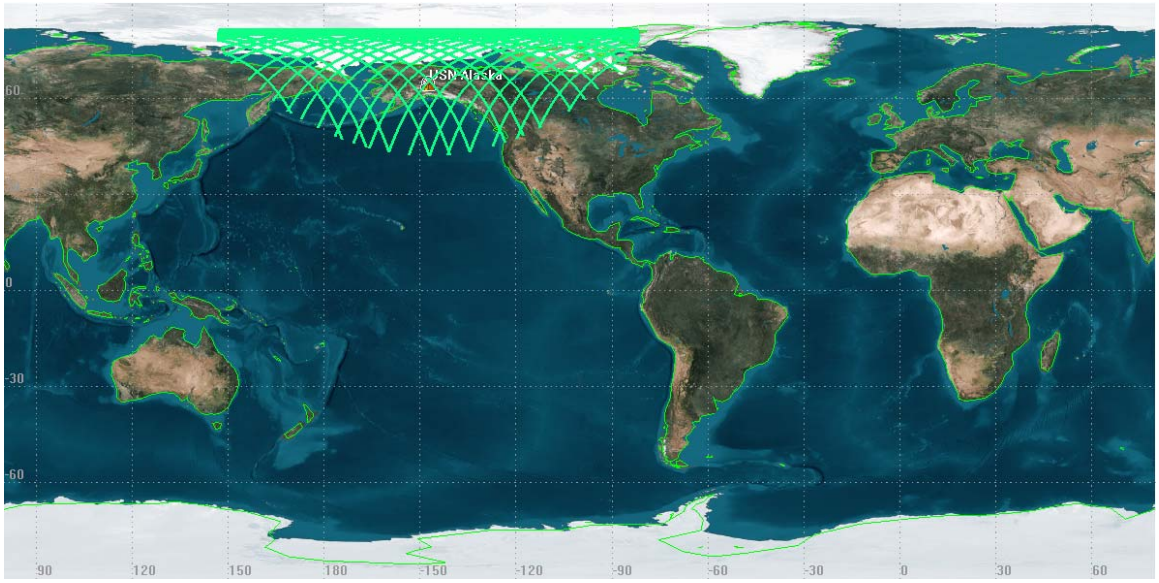
USN pre-LEOP ranging measurement support using Sentinels-2A from Alaska

Sentinels-2B will launch in April 2017. In preparation for this launch, USN has been contracted to provide ranging measurements testing using the on-orbit Sentinels-2A spacecraft. This ranging campaign (pre-LEOP) will take place in the months of January-February 2017 and consist of 5 separated calendar days of pass coverage. The Sentinels-2A spacecraft will be supported by the USN Alaska ground station using a downlink frequency = 2254.099 MHz and uplink = 2075.650 MHz, and has been fully coordinated by Comsearch.

The ranging measurement test support schedule is:
January 24th 2017
January 25th 2017
February 7th 2017
February 14th 2017
February 21st 2017

All potential passes are shown below for these dates, but note that only a few passes will be taken each of these days of the ranging campaign.

```
SENTINEL-2A
1 40697U 15028A   16334.17951549  .00000021  00000-0  24533-4 0  9994
2 40697  98.5641  45.9904 0001120  85.7712 274.3613 14.30819422 75097
```



USN Alaska coverage of Sentinels on typical day in January 2017

USN Alaska possible passes for Sentinels-2A on 24 January 2017

Pass	Start Time (UTCG)	Stop Time (UTCG)
1	24 Jan 2017 00:00:00	24 Jan 2017 00:10:28
2	24 Jan 2017 01:38:50	24 Jan 2017 01:47:33
3	24 Jan 2017 03:16:25	24 Jan 2017 03:25:27
4	24 Jan 2017 04:53:32	24 Jan 2017 05:04:31
5	24 Jan 2017 06:31:38	24 Jan 2017 06:44:06
6	24 Jan 2017 08:11:42	24 Jan 2017 08:23:42
7	24 Jan 2017 09:54:46	24 Jan 2017 10:02:40
8	24 Jan 2017 18:32:07	24 Jan 2017 18:39:40
9	24 Jan 2017 20:11:00	24 Jan 2017 20:22:55
10	24 Jan 2017 21:50:36	24 Jan 2017 22:03:06
11	24 Jan 2017 23:30:11	24 Jan 2017 23:41:13
12	25 Jan 2017 01:09:17	25 Jan 2017 01:18:23
13	25 Jan 2017 02:47:15	25 Jan 2017 02:55:56
14	25 Jan 2017 04:24:20	25 Jan 2017 04:34:42
15	25 Jan 2017 06:02:01	25 Jan 2017 06:14:12
16	25 Jan 2017 07:41:25	25 Jan 2017 07:53:50
17	25 Jan 2017 09:23:24	25 Jan 2017 09:33:08
18	25 Jan 2017 18:03:12	25 Jan 2017 18:07:24
19	25 Jan 2017 19:41:11	25 Jan 2017 19:52:21
20	25 Jan 2017 21:20:41	25 Jan 2017 21:33:17
21	25 Jan 2017 23:00:20	25 Jan 2017 23:11:58

USN Alaska possible passes for Sentinels-2A on 7 February 2017

Pass	Start Time (UTCG)	Stop Time (UTCG)
1	7 Feb 2017 01:19:01	7 Feb 2017 01:27:58
2	7 Feb 2017 02:56:52	7 Feb 2017 03:05:38
3	7 Feb 2017 04:33:56	7 Feb 2017 04:44:30
4	7 Feb 2017 06:11:44	7 Feb 2017 06:24:02
5	7 Feb 2017 07:51:21	7 Feb 2017 08:03:40
6	7 Feb 2017 09:33:40	7 Feb 2017 09:42:52
7	7 Feb 2017 18:12:35	7 Feb 2017 18:18:10
8	7 Feb 2017 19:50:59	7 Feb 2017 20:02:26
9	7 Feb 2017 21:30:32	7 Feb 2017 21:43:07
10	7 Feb 2017 23:10:09	7 Feb 2017 23:21:37

USN Alaska possible passes for Sentinels-2A on 14 February 2017

Pass	Start Time (UTCG)	Stop Time (UTCG)
1	14 Feb 2017 01:09:06	14 Feb 2017 01:18:11
2	14 Feb 2017 02:47:04	14 Feb 2017 02:55:44
3	14 Feb 2017 04:24:09	14 Feb 2017 04:34:30
4	14 Feb 2017 06:01:49	14 Feb 2017 06:14:00
5	14 Feb 2017 07:41:13	14 Feb 2017 07:53:38
6	14 Feb 2017 09:23:11	14 Feb 2017 09:32:56
7	14 Feb 2017 18:03:00	14 Feb 2017 18:07:11
8	14 Feb 2017 19:40:59	14 Feb 2017 19:52:08
9	14 Feb 2017 21:20:29	14 Feb 2017 21:33:05
10	14 Feb 2017 23:00:08	14 Feb 2017 23:11:46

USN Alaska possible passes for Sentinels-2A on 21 February 2017

Pass	Start Time (UTCG)	Stop Time (UTCG)
1	21 Feb 2017 00:59:09	21 Feb 2017 01:08:24
2	21 Feb 2017 02:37:14	21 Feb 2017 02:45:50
3	21 Feb 2017 04:14:21	21 Feb 2017 04:24:30
4	21 Feb 2017 05:51:54	21 Feb 2017 06:03:57
5	21 Feb 2017 07:31:05	21 Feb 2017 07:43:36
6	21 Feb 2017 09:12:45	21 Feb 2017 09:22:58
7	21 Feb 2017 17:53:55	21 Feb 2017 17:55:39
8	21 Feb 2017 19:30:59	21 Feb 2017 19:41:47
9	21 Feb 2017 21:10:26	21 Feb 2017 21:23:01
10	21 Feb 2017 22:50:05	21 Feb 2017 23:01:54

Flux Density impinging on the ground in Alaska from Sentinels-2A
The Flux density is calculated as:

$$\boldsymbol{Flux\ density = EIRP\ \div (4\,\pi\,Rse^2)}$$

Where $\boldsymbol{Rse}$ is the distance from spacecraft to the ground.
Where $\boldsymbol{EIRP}$ is the Effective Isotropic Radiated Power of the Spacecraft.

Data from the spacecraft vendor indicates that the maximum EIRP of Sentinels-1B is -8.83 dBW. The altitude (and thus the closest distance to earth during an overhead pass) is = 692 Km.

Converting -8.83 dBW to scalar watts = 0.130 watts transmitted at 2254.099 MHz

Therefor:

$$\boldsymbol{Flux\ density = 0.13\ \div (4\,\pi\ *\ 692{,}000\ meters^2)}$$

Flux density = 2.160 x 10^{-14} Watts/meter^2
Or
Flux density = 2.160 x 10^{-15} mW/cm^2