# An Approach for Interference Analysis

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# Background

**Competition for spectrum has never been keener**
We share 18 bands[1] with active services
We "own" 21 exclusively passive bands[2]

**For how long?**

Commercial sector deploying increasing systems
We will lose spectrum if we can't analyze sharing impacts and defend what we have

**Now we have sophisticated tools to perform sharing analyses.**
**We know how to use them.**

**Here's how, in a specific application**

[1]ITU-R RECOMMENDATION ITU-R RS.515-4, "Frequency bands and bandwidths used for satellite passive sensing"
[2]International radio regulations 5.340.

# Technique applied to a specific application

Sharing the 31.5-31.8 GHz band

fixed and mobile services and the Earth exploration-satellite service (passive)

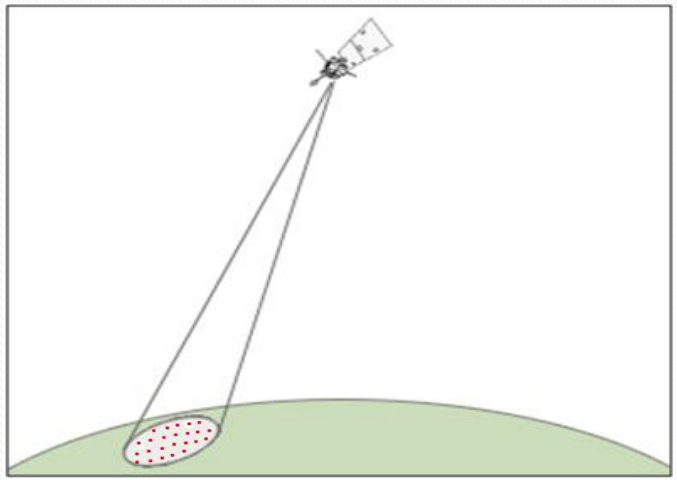
characteristics from fixed and earth exploration satellite services
(FS and EESS)

(no known plans by mobile service)

# Technique

1. **Assign characteristics to emitters and sensor**
2. **Scan a region of emitters with the sensor**
3. **Examine the output for sensed emission values**
4. **Compare results to existing interference standards**

Standards for satellite passive sensing are in ITU recommendations on performance and interference criteria [1, 2] .



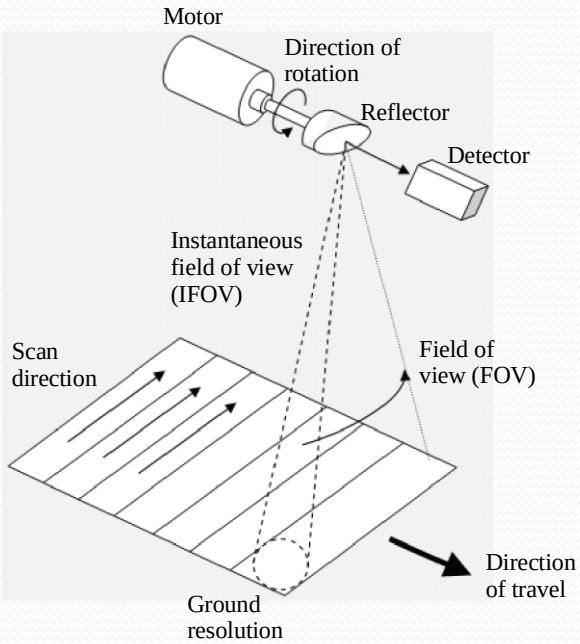
[1]ITU-R RECOMMENDATION ITU-R RS.1028-2, “Performance criteria for satellite passive remote sensing”

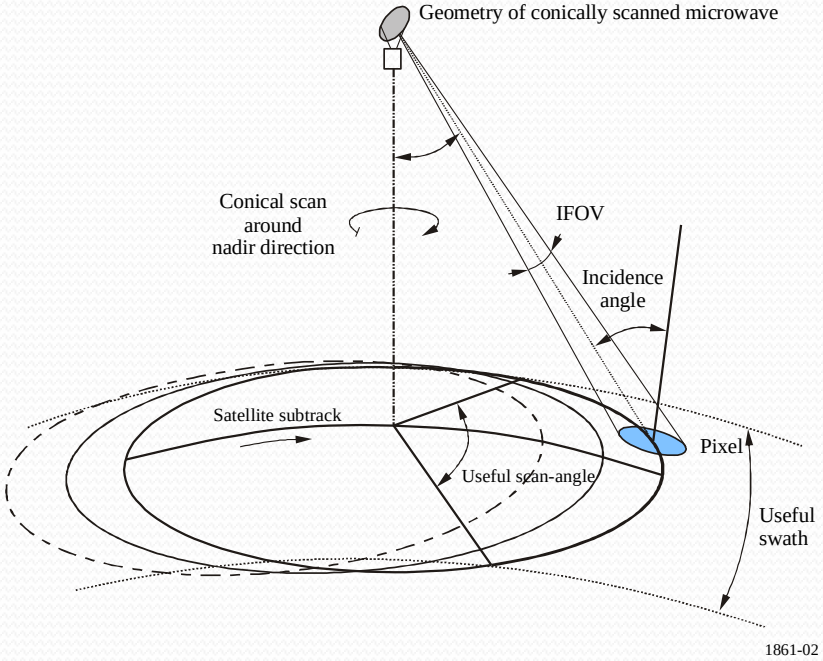
[2]ITU-R RECOMMENDATION ITU-R RS.1029-2, INTERFERENCE CRITERIA FOR SATELLITE PASSIVE REMOTE SENSING

# Characteristics of emitters and sensor

## Sensor characteristics are in an ITU recommendation [1]

### Conical and cross track sensors
### cross track – U.S., Europe, China
### conical – Russian federation




[1]ITU-R RECOMMENDATION ITU-R RS.1861 "Typical technical and operational characteristics of Earth exploration-satellite service (passive) systems using allocations between 1.4 and 275 GHz"

# Characteristics of emitters and sensor

Instantaneous field of view (IFOV)

| | **AMSU-A** | **ATMS** | **MTVZA-OK** |
|---|---|---|---|
| Approximate horizontal dimensions | Nadir FOV: 48.5 km | Nadir FOV: 74.8 km | 30 km × 69 km |
| Approximate area | 1 856 $km^2$ | 4 393 $km^2$ | 1 625 $km^2$ |

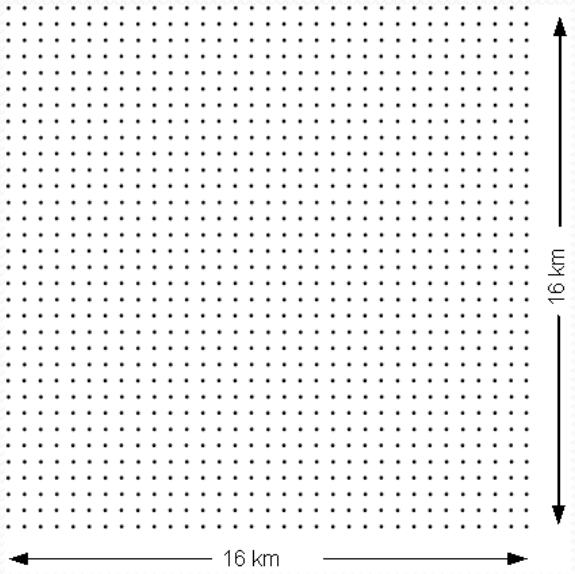
# Characteristics of emitters and sensor

**emitter characteristics are sometimes provided by the service**
**Critical elements of characteristics:**

| |
|---|
| Maximum emitter power |
| Antenna gain |
| Antenna diameter |
| Antenna type |
| Antenna pattern |
| Ratio of antenna diameter over the wavelength (calculated) |
| Respective antenna side-lobe gain from Rec. ITU-R F.1245-1 (calculated) |
| e.i.r.p. (maximum) |
| Channel spacing |
| Deployment scenario |

# Scan a region of emitters with the sensor

emitters are placed every 500 metres in areas of various horizontal extent

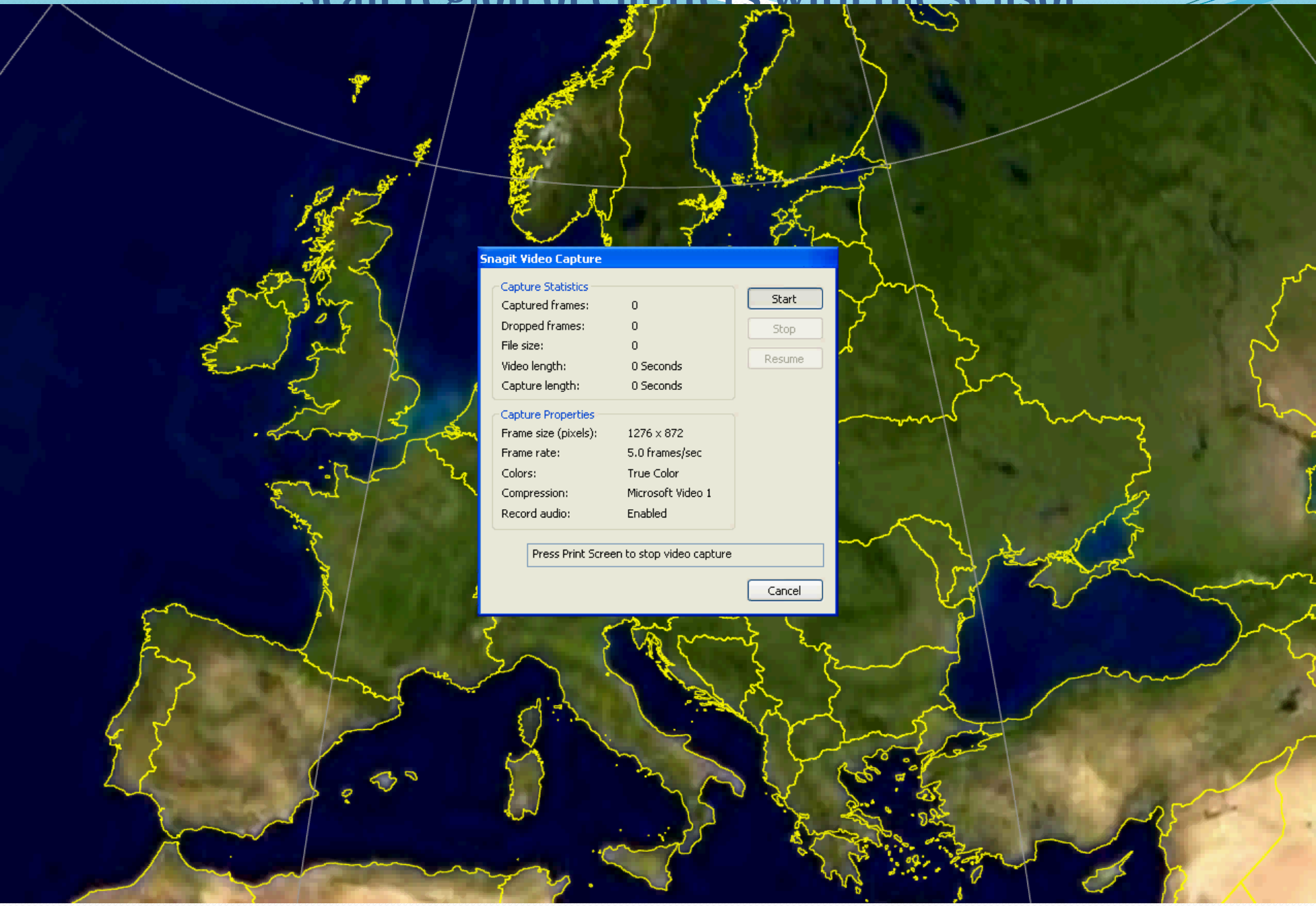



The smallest  area, with 1,089 emitters

# Scan a region of emitters with the sensor

a passive scanner is “orbited” and periodically scans the area

# Scan region of emitters with the sensor



# Compare results to existing standards

Recommendation ITU-R RS.1029-2 -permissible interference levels use in sharing studies.

in this case the level is −164.24 dBW/300 MHz

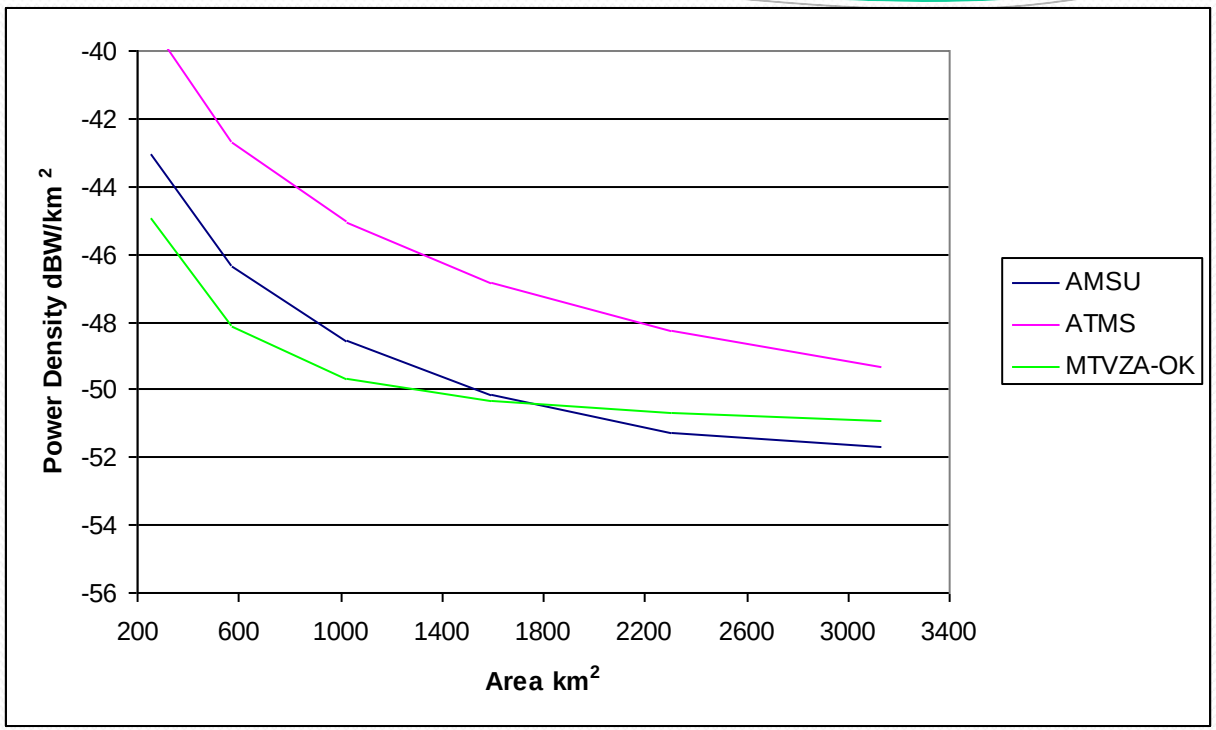
# Compare results to existing standards

Run simulations iteratively adjusting emitter power until interference level is reached

ATMS results

| rectangle width | Rectangle area | Number of emitters | Power for each emitter (dBW) | Total power from the rectangle | Power density = total power divided by IFOV area (dBW/km$^2$) |
|---|---|---|---|---|---|
| 16 km | 256 km$^2$ | 1 089 | −45.50 | −15.13 | −39.21 |
| 24 km | 576 km$^2$ | 2 401 | −48.91 | −15.11 | −42.71 |
| 32 km | 1 024 km$^2$ | 4 225 | −51.12 | −14.95 | −45.06 |
| 40 km | 1 600 km$^2$ | 6 561 | −52.97 | −14.80 | −46.84 |
| 48 km | 2 304 km$^2$ | 9 409 | −53.35 | −13.61 | −47.24 |
| 56 km | 3 136 km$^2$ | 12 781 | −55.46 | −14.391 | −49.35 |

# Summary results for all simulations and sensors




AMSU-A and MTVZA-OK are more sensitive than the ATMS.

The worst case sensitivity is for the AMSU for large areas (large number of emitters)
In this case the power density is −51.97 dBW/km$^2$

# Summary results for all simulations and sensors

Adjust −51.97 dBW/km$^2$ for

- polarization loss
- gaseous attenuation
- antenna side-lobe gain

The limit is −40.62 dBW/km$^2$ (for AMSU-A)

# actual deployment advertised[1] by Fixed Service

a typical emitter would have −18 dBW power

Means an emitter density of 0.0055 emitters/km$^2$
Or a large city (3,139 km$^2$) there could be 17 emitters

If 2 000 emitters are in the cities[1] the deployment density is 0.154 emitters/km$^2$.

To meet the interference threshold of -40.62 dBW/km2 each emitter could have only −32.5 dBW of power…Fixed service advertises -18 dBW/emitter

[1]ITU-R **Working Party 5C** REPLY LIAISON STATEMENT
TO WORKING PARTY 7C INFORMATION REGARDING STUDIES UNDER QUESTION ITU-R 232-1/7

# Results and conclusion

deployment density provided by the fixed service would not be compatible with the sensor.

(compatible configurations would have an average of 17 or fewer emitters per city at typical power levels)

These results were presented during ITU-R meetings in September 2011[1]

[1] ITU-R SG-07 Draft new Report IUT-R RS.[31.5 GHZ SHARE] - Sharing the 31.5-31.8 GHz band by the fixed and mobile services and the Earth exploration -satellite service (passive)