GROUNDSPACE

NGSO User Terminal Detection & Localisation

INTRODUCTION

Groundspace provides ground-based RF Space Domain Awareness capabilities, delivering visibility into the new generation of satellite constellations — from ground to space.

CelesGuard	*LEO/MEO/GEO satellite downlink monitoring*
CelesGuard DTC	*Direct-to-Cell satellite monitoring*
EPFDGuard	*NGSO EPFD validation in partnership with* KRATOS
SIGRID	*Satellite detection, characterisation and cataloguing*
WHISPR	*NGSO satellite terminal detection and localisation*

THE CHALLENGE

- Satellite connectivity is increasingly global, while the authorisation of satellite communications remains a national responsibility
- NGSO user terminals are small, portable and increasingly mobile, allowing terminals to cross borders and operate in territories where their transmissions may not be authorised
- National administrations therefore need to know which satellite systems are being accessed from their territory, where the terminals are located and when they are active
- Obtaining this visibility without relying on satellite operators can be challenging
- Independent detection, identification and geolocation provide administrations with a means to verify actual spectrum use and investigate unauthorised transmissions towards satellites

HOW CURRENT TERMINAL GEOLOCATION SYSTEMS WORK?

Existing satcom terminal geolocation solutions rely on one of two assumptions:

The protocol can be exploited

- Protocol decoding or analysis
- Extraction of location information

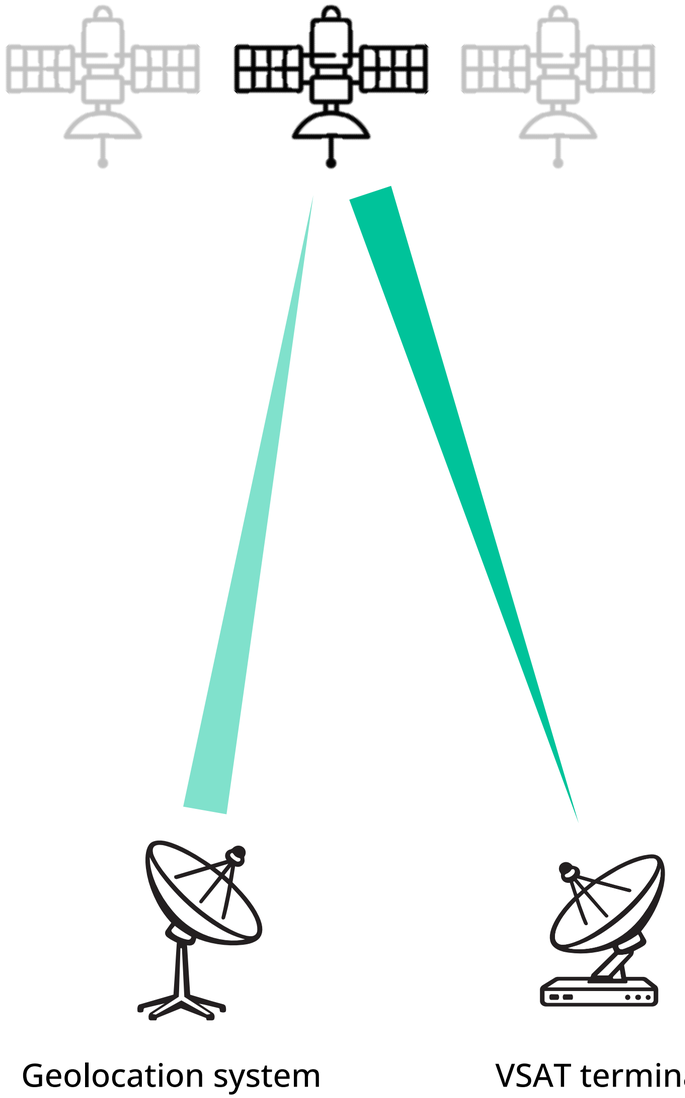
The network is accessible

- Interception of downlink traffic
- Geolocation using TDOA/ FDOA measurements

With modern constellations, these assumptions no longer hold!

CURRENT SYSTEMS LIMITATIONS

- Existing systems were designed for satellite phones and conventional VSAT terminals
- Terminals used by modern NGSO constellations present new challenges:
  - *Traffic is no longer directly accessible*
  - *Protocols are proprietary and highly secure*
  - *Terminals use highly directional beams*



HOW CAN WE LOCATE MODERN NGSO TERMINALS?

Two approaches are available:

1. Exploit the downlink

- Observe transmissions from NGSO satellites
- Detect activity over a given beam/cell
- Identify areas in which to focus further investigation

2. Exploit the uplink

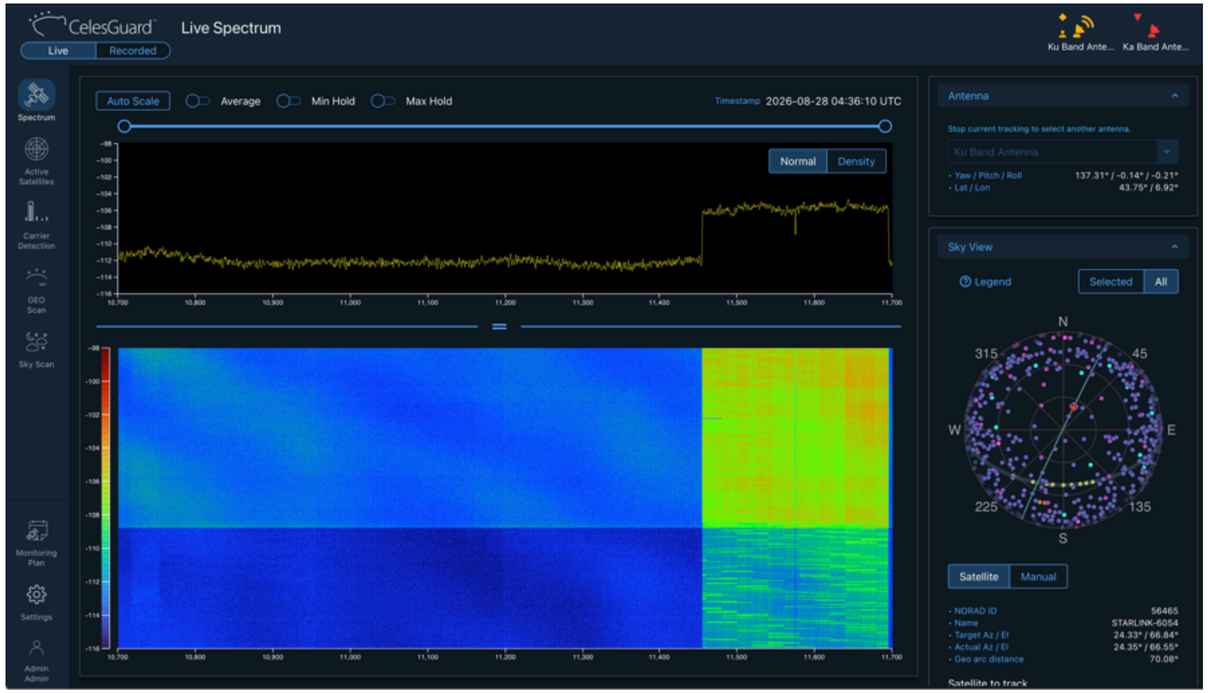
- Directly detect uplink transmissions from user terminals
- Determine their direction, then obtain a precise location
- Guide field investigators towards the target

These two approaches are complementary and address different operational needs.

CELESGUARD: DOWNLINK MONITORING

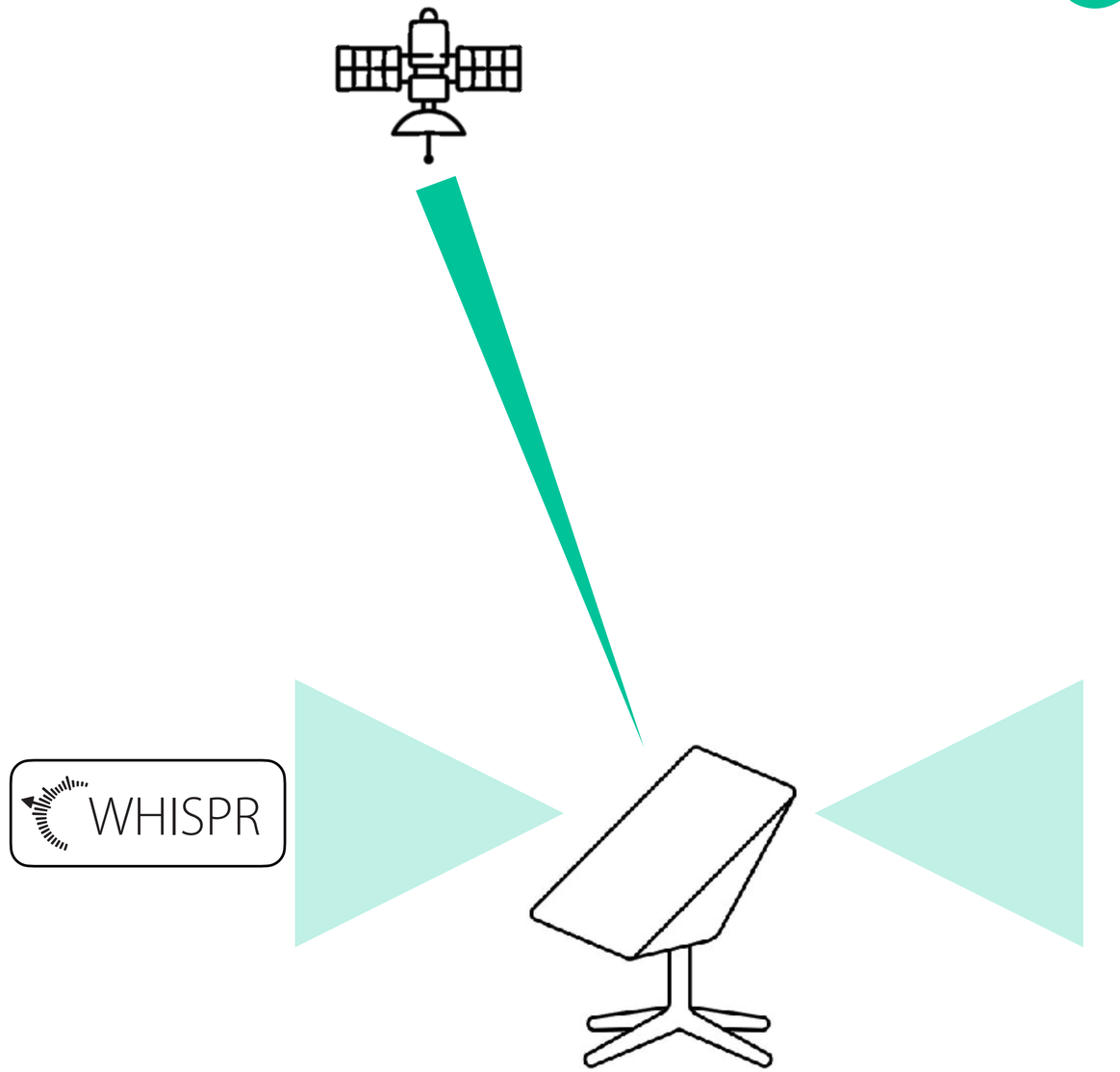
- We provide an RF monitoring system capable of detecting, monitoring and recording signals from constellations operating in the Ku and Ka bands:
  - Starlink, OneWeb, Amazon LEO, Qianfan, Rassvet, …

CelesGuard®



WHISPR: UPLINK MONITORING

- Satellite terminals transmit a highly directional signal towards the satellite
- A small fraction of this energy leaks outside the main beam as side lobes
- Whispr passively detects these side lobes from the ground
- The detected signal can then be used to determine the direction or location of the terminal



Whispr does not detect the satellite. It detects the terminal.

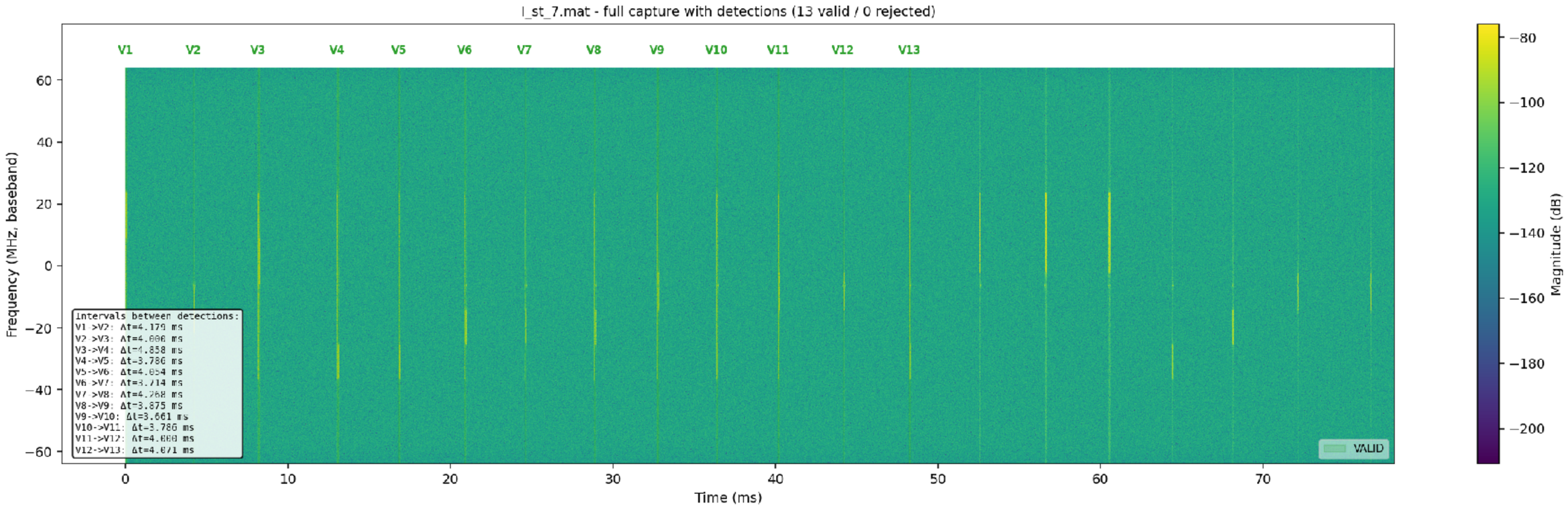
WHISPR: BEYOND SIMPLE ENERGY DETECTION

- Detection through antenna side lobes is not a new approach
- However, existing systems rely primarily on received energy detection:
  - Susceptible to interference and unrelated emissions
  - Difficulty distinguishing a Starlink terminal from other signals in the Ku band
  - Limited detection range when signal levels become very weak

WHISPR: SUPERIOR DETECTION PERFORMANCE

- WHISPR's performance does not rely solely on receiver sensitivity
- WHISPR leverages our unique knowledge base, built through several years of analysing NGSO constellation signals
  - *Correlation of received signals with known uplink signatures*
  - *Reduced false alarms in complex electromagnetic environments*
  - *Detection of very weak signals, under the thermal noise floor, enabling greater operational range*

WHISPR: SUPERIOR DETECTION PERFORMANCE



Repeating headers

WHISPR: ONE TECHNOLOGY, THREE CONFIGURATIONS

WHISPR is designed around three configurations to address different operational requirements.

SCOUT

Short-range detection

- Confirmation of terminal presence
- Guidance for field investigators

HUNTER

Continuous surveillance

- Autonomous detection and geolocation
- Deployment on vehicles, vessels or fixed sites

AIR

Drone-based detection and geolocation

- Extended line of sight
- Rapid search across large areas and/or complex terrain

WHISPR: ONE TECHNOLOGY, THREE CONFIGURATIONS

SCOUT

Handheld detection system

- Portable and rapidly deployable
- Detect and determine the direction of nearby terminals (8+ km)
- Real-time operator guidance
- Designed for field investigation

WHISPR: ONE TECHNOLOGY, THREE CONFIGURATIONS

HUNTER

Mobile platform for continuous surveillance

- Vehicle, vessel or fixed-site deployment
- Long-range detection (25+ km) and localisation (requires 2 systems)
- Fully electronic operation with no moving parts
- Designed for persistent monitoring

No moving parts

WHISPR: ONE TECHNOLOGY, THREE CONFIGURATIONS

AIR

Wide-area search

- Rapidly deployable aerial platform
- Extended line of sight for increased detection range
- Search and localisation across large areas
- Designed for difficult or inaccessible terrain

DETECT. LOCATE. ENFORCE.

- Identify satellite terminal activity within national territory
- Support spectrum licensing and enforcement activities
- Verify operator compliance independently
- Investigate unauthorised satellite terminal use

WHISPR gives regulators independent visibility into satellite terminal activity.