FIGHTING INTERFERENCE WITH TECHNOLOGY

Martin Coleman
The Satellite Interference Reduction Group (IRG[*]), martin.coleman@satirg.org

ABSTRACT

The satellite industry has been working hard to reduce the global effects of satellite interference. Interference is caused from a number of sources however, no matter what that is, one of the key tools is innovation and technology. Indeed, in order to be successful in mitigating satellite interference, we need to invent new, and improve existing technologies.

Technology is already moving forward, citing, for example, the Carrier Identification (Carrier ID) technology, now approved by the Digital Video Broadcast group (DVB) and formalized as a standard by the European Telecommunications Standards Institute (ETSI).

The next step is implementation. The session will examine the roll out of the new technology across modulators, DSNG encoders and modems and the processes involved. The speaker will discuss what is involved in implementing Carrier ID[†] and the role of satellite operators, manufacturers, and what the users need to do to ensure widespread global implementation.

The session will also cover a summary of Geolocation and how from that technology enhancements to standardise output data reporting, develop predictive and suppression techniques as well as data sharing and the Space Data Association (SDA).

CARRIER ID

Two technologies currently exist…

1. NIT Carrier ID (NIT-CID) – developed mainly for Digital Satellite News Gathering (DSNG) Encoders but available in a high proportion of all single thread Encoders. It uses the initial Network Information Table (open format, not encrypted) available within the DVB stream. Developed in 2006 by Colem and Link Research (now Vislink) and supported by IRG;

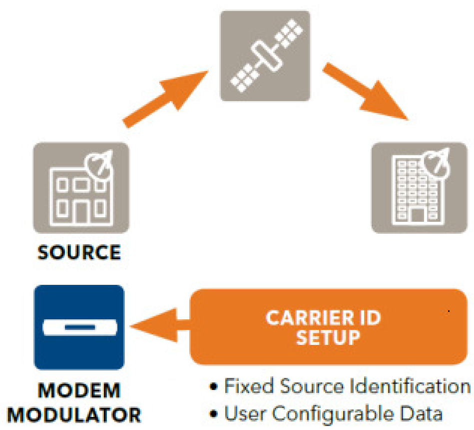
2. DVB Carrier ID (DVB-CID) – a new technology using spread-spectrum techniques to add a separate and resilient carrier under any Single Channel per Carrier (SCPC) or Multiple Channels per Carrier (MCPC) transmission method carrying streamed content or pure Data/IP. This is independent of the DVB or Data Stream the contained content. Developed by Comtech EF-Data and supported through a specific IRG Working Group, Newtec then joined the development team to be able to work through the DVB and formalize the open industry specification which has now become an ETSI Standard[‡].

[*] IRG Website for more information and contact details go to… www.satirg.org
[†] During 2013 a survey was conducted by IRG and Newtec on Interference and Carrier ID – Results at… http://pages.newtec.eu/rs/newtec/images/Carrier%20ID%20Demystified%20booklet%20-%20Newtec%20and%20IRG%202013%20.pdf
[‡] ESTI Specification available via this link… http://www.etsi.org/deliver/etsi_ts/103100_103199/103129/01.01.01_60/ts_103129v010101p.pdf

How DVB-CID works…

An Identifier Is Injected into the Carrier at the Modulator…

The identifier contains mandatory information such as a 64-bit MAC address or a vendor serial number in combination with optional user configurable data such as GPS coordinates, the carrier name and user contact details. This information is injected into the carrier by the modulator at the uplink site.

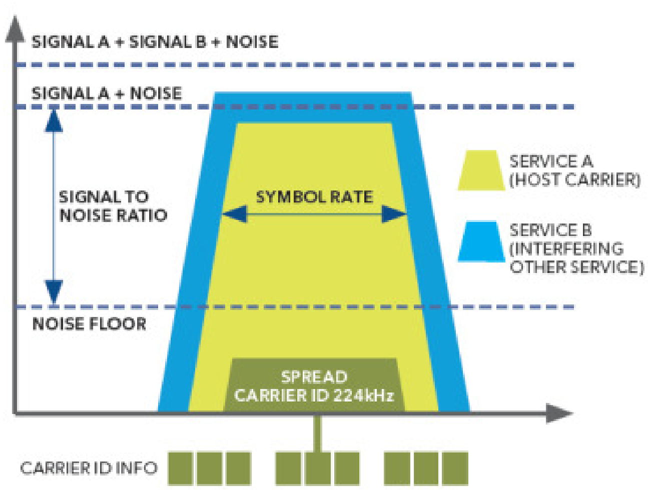


The Carrier ID Is Transported over Satellite below the Noise Floor…

In order to lower the impact on the throughput over the satellite, the carrier ID information is spread below the noise floor of the carrier. The image depicts an instance of interference between two carriers and the location of the Carrier ID info.

The ID Is Read from the Carrier by Special Measurement Receivers

At the satellite operator facilities special measurement receivers are installed. At any occurrence of interference these receivers can read out the contact information from the carrier and quickly point out the source of interference. Resolving the interference issue is in most cases only a phone call away.



Advantages & Disadvantages of each Carrier ID method…

Carrier ID Method…	Advantages	Disadvantages
NIT Carrier ID…	a) Simple to implement & use. b) Free of charge firmware upgrade for the majority of single thread/DSNG Encoders. c) Covers the main focus of accidental interference events from SNGs and Flyaway Terminals.	i) Not resilient. The known carrier must be taken out of service to read the Carrier ID of the interferer. ii) Only suitable on DVB streamed services. iii) Limited time as DVB-CID to become the global single SCPC and MCPC solution.
DVB Carrier ID…	a) Added as part of the Radio Frequency (RF) signal within Modulator and independent of stream and content. b) Resilient CID, both service & interferer Carrier IDs can be detected during the interference event. c) Available for any type of SCPC or MCPC service whether DVB Stream, NS3 or any Data/IP type. d) Already 70% availability on all latest Modulator products e) Planned three year roll out starting 1st January 2015 to allow equipment upgrade & ability to use the NIT-CID in the interim. f) High take-up within the industry as very few modulator providers & all have either added CID or completing implementation by end 2014.	i) To implement will require a broadcaster to renew modulators or single thread or DSNG encoders. *Note: with DVB S2 Extensions and the Carrier ID rollout plan allows for this becoming a natural upgrade path over time.* ii) Relatively few of today's modulator systems that are in service will allow simple firmware upgrade and cost involved albeit small. iii) DSNG Encoders on a slower timetable to rollout but certainly available from some suppliers by the end 2014 and by the early part of 2016 it will be commonly available across all suppliers. iv) Not suitable on VSAT burst mode/TDMA or centrally controlled systems.

Common Carrier ID Database through the SDA…

The SDA is finalizing the development of a global Carrier ID database for use in the resolution of detected and identified carriers. This database will be open to all satellite operators, both members and non-members, to allow the free flow of exchanging IDs to allow the responsible satellite operator to deal directly with the interfering transmission. The following outlines the "Use Cases" for Carrier ID and how the interaction of this database shall be implemented. It is expected that over time, many of these procedures will be fully automated.

CARRIER ID "USE CASES"…

The ability to add an ID to a satellite carrier is straight forward and fairly easy to implement using either the NIT method or the DVB CID method. The ability to detect the ID from a satellite carrier is also fairly straight forward, though a more complex technical solution. However, designing, implementing, and using a system that properly handles the ID, once it is detected, is quite involved. Any Carrier ID Detection System should be able to accomplish the following:

- Detect the Carrier ID on more than one polarity and satellite (multiple RF sources)
- Ensure the association between Uplinkers and IDs is kept private, owned, and controlled by a satellite access center (the company that authorized the actual transmission)
- Determine if an ID is legitimate, with input from a human operator
- Reliably publish, in the central database (expected to be housed within the Space Data Centre (SDC) of the SDA), the association between IDs and a satellite access center
- Provide background detection and publishing of legitimate IDs
- Allow manual investigation of operator-specified bandwidth
- Assist the satellite operator with determining who to contact when an unauthorized ID is detected

DEFINITIONS

For the purpose of the following use cases, the following terms are defined as follows:

- Satellite Uplinker – Any earth station that transmits RF to a satellite
- Satellite Access Center – Any organization or individual that authorizes a satellite Uplinker to initiate transmission to a satellite; satellite operators have their own access centers, but there are also access centers at teleports and other satellite users that control access to leased satellite bandwidth
- Satellite Operator – Any organization that is responsible for the payload of one or more satellites; this organization has the ability to join the SDA and help resolve RF interference
- SDA – Space Data Association, and association of satellite operators that enables the sharing of data to assist with the flying of satellites and the resolution of RF interference

CARRIER ID USES CASES AND WORKFLOW

The workflow required to make Carrier ID an effective tool in reducing the time required to recover from accidental interference or to detect unauthorized users requires planning and interaction with multiple systems. The following provides suggestions for potential workflow from different users' perspectives and those users' operational scenarios.

Note that it takes 20-75 seconds for a Carrier ID to be detected on a carrier. Therefore any Carrier ID detection system used must be able to handle the necessary delay required to extract the Carrier ID from carriers.

UPLINKER VERIFIES THEIR CARRIER ID

As per the latest FCC rulings, from 1st June, 2016 all Satellite News Gathering (SNG) and temporary or Occasional Use (OU) video transmissions within the U.S. are required to have either Carrier ID or the original Automatic Transmitter Identification System (ATIS). However, Satellite Operators will be encouraging DVB-CID on all video and data transmissions. The cost to embed a Carrier ID is small however the cost to detect Carrier ID can be prohibitive. This use case assumes an Uplinker will have DVB-CID attached to their carrier and requires a method for verifying the existence of their Carrier ID within their own carrier.

The Uplinker sends the following information, via a web services request, to a Carrier ID Detection System and receives either a "validation confirmed" or a "validation failed" response:

- RF Source – Satellite and Polarity
- Center Frequency
- CID that should be attached to the carrier

The Carrier ID Detection System will detect the CID at the RF Source and Center Frequency specified; if they match, the Carrier ID Detection System will respond with a validation confirmed message, and if they do not match, the Carrier ID Detection System will respond with a validation failed message.

The Carrier ID Detection System can be located near the transmitting earth station, or anywhere within the satellite's downlink beam.

SATELLITE ACCESS CENTER DETECTS ID

Since the access center will have a business relationship with the Uplinker they should know how to contact the Uplinker and must know that Uplinker's Carrier ID.

Therefore, after an access center grants authorization to an Uplinker and the Uplinker successfully transmits, the access center will need to extract the CID from the Uplinker's carrier and associate the extracted Carrier ID with that particular Uplink, and the list of individuals associated with that uplink. The logical place for that association to occur is in the access center's customer database (or transmission log, or whatever they use to know who is allowed to transmit on space segment under their control.)

The access center, therefore, sends the following information to a Carrier ID Detection System and receives a response that contains a CID:

- RF Source – Satellite and Polarity
- Center Frequency
- Access Center Central Database Identifier (this identifier is assigned by the central database when the access center registers with the central database)

The Carrier ID Detection System can be located near the access center, or anywhere within the satellite's downlink beam.

The Carrier ID Detection System shall detect the CID at the RF Source and Center Frequency specified; if a Carrier ID is found the Detection System will respond with the Carrier ID and it will be the responsibility of the Access Center to link the Carrier ID with the Uplinker, and if a Carrier ID is not found the Detection System will respond with a Carrier ID not found message. The Detection System will also insert a record in the Central Database linking the detected Carrier ID, if found, with that Access Center.

Satellite Access Centers should also plan to have background monitoring that will cycle through their controlled space segment and validate the presence of expected Carrier IDs. The background monitoring should function just like the initial detection, but at a lower priority than initial detection requests.

SATELLITE OPERATOR MONITORING AND CONFLICT RESOLUTION

Once the satellite operator obtains the list of Carrier IDs that are present for conflicting carriers, the satellite operator queries their own customer database to determine if they have a business relationship with each of the Uplinkers. If so, they contact the Uplinker that is causing interference and ask them to stop. If not, the satellite operator queries the Central Database for all the Carrier IDs in the list that they do not have a business relationship with and the Central Database returns a list of Access Centers that should have business relationships with the Uplinkers. The satellite operator then contacts the responsible Access Center(s) and requests that the center(s) contacts the interfering Uplinker associated with the particular Carrier ID. The Access Centre then has the responsibility to request that the interfering Uplinker corrects the issue.

DVB formal statement on deriving the DVB-CID…

Radio Frequency Interference (RFI) highly impacts Quality of Service for satellite operators and their customers. This in particular applies to occasional use satellite transmissions and temporary feeder links, rather than to full time Direct to Home (DTH) services, often caused by failed equipment or by an improperly configured system due to human error.

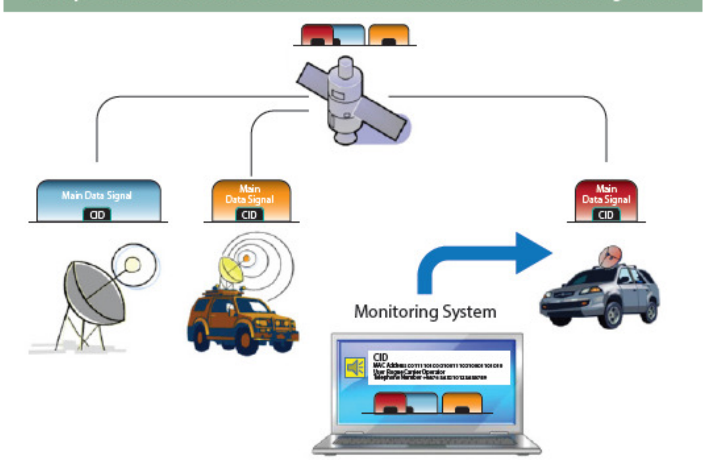
With the objective to develop countermeasures against the so called 'rogue carriers', DVB assigned to the TM-S2 Ad-Hoc Group the task to define a satellite transmission system for Carrier Identification (Carrier ID).

As reported as part of the DVBs Commercial Requirements process, Carrier ID is not expected to be a perfect solution to solve all RFI, but it will be a key technology in contributing to the rapid identification of RFI and reducing its negative impact to operators, customers, and the satellite industry as a whole. Furthermore, the Commercial Requirements state that Carrier ID is not required for transmitters that are fully controlled by a hub based network management system, since for these the interferer could be identified reliably by means other than an explicit Carrier ID signal. This is, for example, the case for low-cost VSAT equipment, for which the inclusion of a Carrier ID signal could be critical.

Carrier ID is meant to enable the operators and users to quickly identify interfering carriers and respond to RFI, reducing the duration of each event, improve Quality of Service and reduce operating costs. Also in the longer term, lower the number of RFI events and release bandwidth being used to overcome current and ongoing RFI events. The availability of a DVB standard for Carrier ID will enable the industry to produce interoperable equipment and also will ensure an ongoing development and improvement of Carrier ID technology in a standardized manner.

The activities of the DVB-S2 group started in March 2012, with the conversion of the Commercial Requirements into technical ones, and the definition of a baseline system which underwent refinements until the end of 2012. To allow for the Carrier ID to be virtually compatible with all carriers used in satellite today (to be considered unknown in terms of waveform and synchronization), and easy to be included in all satellite modulators, the baseline solution is based on the superimposition of a Spread Spectrum Meta-carrier (MC) to the main Data Carrier (DC). Two fixed values are proposed for the CID chip rate, 112 and 224 Kbit/depending on the DC symbol rate, in order to simplify acquisition/detection. To allow for a negligible degradation of the DC performance (typically below 0.1 dB), the MC will have a predefined Power Spectrum Density level, well beneath the DC level. At the same time, the adoption of Spread Spectrum technique, together with the Differentially Encoded BPSK modulation and a BCH FEC (Forward Error Correction) protection, allows for a very robust Carrier ID system. It should in fact be possible, in the majority of practical cases, to identify the interferer without switching-off the wanted signal, as particularly required by broadcast services.

Example of satellite interference: CID allows the identification of interfering carriers



The message transported by the MC will include, at a minimum, the MAC address of the equipment and the Carrier ID format version (to allow for future extensions and improvements). Additional information can optionally be transmitted, configurable and editable by the user, which can contain information such as Uplinker name, contact phone number, etc., to help in the RFI identification. A common database is expected to exist, accessible by all satellite operators and possibly other authorized entities, which will contain all of the Carrier ID codes and the name of the satellite operator whose satellite is carrying each respective carrier.

The packet format allows for a rapid identification of the RFI: the MAC address is repeated every few seconds, so that it can be possible to identify the RFI in less than 15 seconds during line-up, and less than 1 minute during operation. The commercial requirements indicate respectively 1 minute and 15 minutes: the available margin can be used by receiver designers for reduced complexity algorithms that implement automatic detection with respect to massive parallel reception.

Arab States Broadcasting Union (ASBU) Action Plan…

The ASBU Satellite Interference Forum held in Tunis (6-7 October 2013) developed the ASBU Action plan of which, Carrier ID is a part. The reason for adding this information to this paper is that this action plan shows the commitment from commercial broadcasters to improve the industry and the way it operates by investing in the global initiatives being pursued by various industry groups. The plan includes…

1) Awareness

ASBU and operators in this region and other regions to establish a public awareness campaign through different Mass Media that intentional interference will not prevent the Media message to be delivered, as the broadcasters affected will move and find other strategies or alternatives (the use of another satellite, other frequencies or other means of Media).

Broadcasters in the Region should use their access to media to publicize the impact of satellite interference on broadcasting.

2) Training

ASBU and operators in this and other regions shall endeavor to establish short and medium training plans for all broadcasters to ensure that best practices in both operation and maintenance of satellite uplinks with the objective of significantly reducing the number of interference incidents. Training to be delivered using ASBU, the Global VSAT Forum (GVF) and recognized training plans such as the GVF SNG module developed jointly with the IRG- End User Initiative (EUI) Working Group as well as other specialized training providers for satellite Operations and Network Operation Centers (NOC), etc.

3) Earth Station Approvals

ASBU and operators in this region and other regions to request that SNG terminal equipment be tested and approved for use in coordination with GVF's Quality Products Framework, which has been endorsed by both the IRG-EUI and WBU-ISOG in order to reduce interference caused by faulty satellite newsgathering ground equipment.

4) Carrier ID

ASBU and operators request that all members and users in the Region implement Carrier ID in line with the WBU-ISOG Resolutions and to record and measure the progress in implementing this initiative. All Broadcasting Unions and members of this region are to engage with their national regulators with the view to making Carrier ID a requirement.

5) Regulatory and Political Actions

ASBU, WBU, satellite operators and all concerned parties recognize the actions of the ITU Radio Regulations Board and the Telecommunication Standardization Bureau (TSB) in order to tackle the issue of intentional interference. Their continued support is requested to develop these initiatives. ASBU and WBU will also consider whether it is appropriate for action to be taken by other competent UN bodies such as the United Nations Institute for Disarmament Research (UNIDIR) and others.

5.1) Broadcasters to build relationships with their regulators and ITU recognized Administrations in relation to two specific subjects:

a) The protection of C-Band resource for WRC-15 in close coordination with GVF.

b) Raising awareness of the issue of interference.

5.2) To develop a formal definition of intentional interference; recognizing that the ITU definition of harmful interference[§] does not make such a distinction.

* Action – For ASBU and relevant bodies in the Arab League to work with its members and related organizations to:

a) Draft definitions for intentional and unintentional interference and for this to be proposed with the assistance of Regional Administrations and Broadcast Unions to the ITU, for adoption within the Radio Regulations.

b) Introduce national laws that prohibit and penalize intentional interference.

c) Conduct bilateral coordination among affected countries.

[§] "Interference which endangers the functioning of navigation or other safety radio service or that seriously degrades, obstructs or repeatedly interrupts any radio communication service operation in accordance with the Radio Regulations"

5.3) To work with other Regional Broadcast Unions, the WBU and industry organizations to convince ITU members to:

a) Develop the proposal for an Intentional Interference Register (IIR).

b) Develop a system of penalties to be applied to those members that practice intentional interference.

c) Request ITU apply such penalties on members creating intentional interference. All ASBU member organizations should have a unified approach towards any ITU members subject to such constraints.

5.4) For ASBU members to participate in industry working groups such As sIRG, WBU TC & WBU-ISOG to exert more efforts to find technical solutions to the issue of intentional interference.

5.5) For ASBU and its members to participate actively within the ITU and its relevant study groups to secure and protect the scare satellite resources upon which all broadcasters depend.

5.6) For ASBU and other Regional Unions to recognize that unauthorized use of un-occupied satellite capacity is an issue and to request broadcasters take action to ensure they do not use material or companies that exploit such capacity.

5.7) Ahead of ITU and or other international bodies implementing the suggested changes, ASBU will develop a code of conduct for its members based on the actions proposed in this plan.

Industry led Resolutions for the implementation of Carrier ID…

At the conclusion of the World Broadcast Union – International Satellite Operations Group (WBU-ISOG) Forum (May 15-16, 2013) held at Fox Networks in Los Angeles, there was agreement to issue the following global industry resolutions in support of the recently adopted Carrier ID standard issued by ETSI – ETSI TS 103 129 v1.1.1 (2013 – 05). With this positive step forward by the industry to identify satellite transmissions of video content and as a means to help mitigate satellite interference, WBU-ISOG supports the following resolutions:

<u>Exclusions and their Definition</u>

a. The requirements for transmission of Carrier ID do not apply to MSS systems which automatically configure frequency, power level, polarization and transmit inhibit according to commands issued by a central control mechanism which is in the control of the satellite operator.

b. The ETSI TS 103 129 v1.1.1 (2013 - 05) standard does not address systems that use TDMA or other types of burst carriers, and as such, equipment or systems that use TDMA or burst carriers are excluded at present from these resolutions.

RESOLUTIONS:

i. WBU-ISOG supports the requirement that, by no later than January 1, 2015, all new model modulators and codecs with integrated modulators purchased by end users for video uplinking contain a Carrier ID (CID) that meets the ETSI TS 103 129 standard issued May 29, 2013.

ii. Based on Resolution (i) and with immediate effect, the WBU-ISOG supports the requirement that all Uplinkers of SCPC and MCPC Video and Data, fixed and mobile systems shall include Carrier ID functionality in the required specifications of all current and future RFP's (Request for Proposal) or RFQ's (Request for Quote) issued to equipment manufacturers regarding the purchase of modulators and/or codecs with integrated modulators.

iii. The WBU-ISOG supports the requirement that all satellite operators, by no later than January 1, 2015 start the transition to use Carrier ID that meets WBU-ISOG NIT or the ETSI standard for all SNG, DSNG and any other New Uplink transmission services.

iv. The WBU-ISOG supports the requirement that all Uplinkers by no later than January 1, 2018 shall ensure that Carrier ID is included for all their respective SCPC and MCPC Video and Data transmissions.

v. The WBU-ISOG supports the requirements that CID NIT shall be phased-out in preference to the ETSI standard by January 1, 2018.

Implementation summary to meet the Carrier ID transition date of 1st January, 2015…

- DVB-CID ETSI Standard completed May 2013
- NIT-CID Available
- 70% of all supplied Modulators are DVB-CID ready now!
- 80% of all supplied Encoders are NIT-CID ready now!
- SDA CID Database in production (ready for testing - June 2014)
- Detection Systems for both DVB-CID and NIT-CID available now!
- Eutelsat, Intelsat & SES implementing Carrier ID Monitoring Systems now!
- WBU-ISOG Resolutions created CID targets! (May 2013)
- ASBU Action Plan requires DVB-CID (Oct 2013)
- FCC require **ALL** SNG/Flyaway Broadcast Platforms to be Carrier ID compliant by 1st June 2016

SUMMARY OF GEOLOCATION ACTIVITIES

Geolocation is used to resolve those difficult cases and intentional interference events where other methods fail. Moving forward with Geolocation...

Reporting standards:

Using the data collected from Geolocating the source of an interferer there is a need to construct and common format standard, ensuring harmonised reporting from all Geolocation suppliers. This is has been driven by the recent needs of the International Telecommunications Union (ITU) to report harmful interference events accurately and consistently and thus ensure the evidence created is always presented in a common agreed format.

Standardised Processes:

Moving on from reporting is to ensure that the processes or steps to accomplish successful Geolocation are common and follow a standard such as ISO.

Predictive Geolocation:

Knowing the commercial target service (e.g. Voice of America (VoA), BBC World Service, etc.) means that each and every service can be given a priority code to prioritise monitoring and using pre-set Geolocation data sets to allow immediate target acquisition if interference is detected and speed up the resolution process.

Suppression Techniques:

Using the techniques to detect carrier under carrier situations using DSPs this can be applied in reverse to suppress the incoming interferer/noise.

Data Sharing and the SDA:

Geolocation requires up to date ephemeris data of satellite positions and an accurate database of known reliable reference carriers as well as coverage patterns increase the accuracy of pinpointing interference sources. The SDA is looking at ways of making this available globally.

International Monitoring:

For the ITU the importance of calibrated monitoring stations that need to work with combined and synchronised Geolocation with the pronating satellite operator and, possibly, engaging with private suppliers with similar capabilities. This evidence can be presented (in a common format) from multiple monitoring stations at the same time thus, making that evidence irrefutable.

OTHER FUTURE TECHNOLOGY INITIAVES

Smart Receivers:

From this IRG is starting to also look at the development of smart receivers that track the required incoming signal and using suppression techniques and smart filtering to reduce the impacts of transmitted interference.

On-board Geolocation for Commercial Satellites:

The ability to geolocate from space must be considered and effectively resolving true single satellite Geolocation. At present this is confined to military satellites is expensive. Our thinking is to consider a COTS approach to building an internationally costs effect add on solution for all satellites.

More Identification:

Both unique Satellite ID and Transponder ID to ensure correct access, especially for the numerous auto-deploys now on the market.

End of Paper

(FIGHTING INTERFERENCE WITH TECHNOLOGY)