2114 West 7th Street
Tempe, AZ 85281 USA
Voice +1.480.333.2200
E-mail sales@comtechefdata.com
Web www.comtechefdata.com

Carrier ID Using MetaCarrier® Technology

Satellite operators and service providers spend a considerable amount of time on their attempts to reduce interference. There are both capital and operational expenses incurred for this effort. Capital expense elements include investment in high value tools such as those from Integral Systems, Glowlink, or Crystal Systems. Operational expenses can include subscription-based plans from Integral Systems and Glowlink. In addition, there are personnel dedicated to identifying and reducing sources of interference. There is also the lost opportunity cost; partial or whole transponders not available for use by the satellite operator.

There are long- and short-term causes of interference. Long-term may be from adjacent satellites, which would be due to either lack of coordination between users, outdated or poorly designed equipment, or small mobile antennas. In addition to these reasons, there may be deliberate interference for political reasons, or terrestrial sources, such as microwave links or radar. Short-term causes may be from users, such as cross polarization, or transmitting on the wrong frequency or satellite. It may also be caused by equipment malfunctions or incorrect back-up configurations.

The types of interference are predominantly designated by satellite operators as unauthorized carriers or from incorrect cross/co-polarization; approximately 80% of interference events are between these two types as reported by the operators.

Interference has a financial impact as well to satellite operators and users. When there is interference on a transponder, there is revenue lost due to the reduction of available bandwidth and power capacity. Expenses are increased, ranging from the purchase of interference monitoring or geolocation equipment, or dedicating personnel to interference mitigation. Geolocation systems may be purchased, with costs upwards of $500,000 per system, and a monthly recurring fee of $15,000. There are per use arrangements for geolocation. These are priced in the range of $20 to $30,000 per year per satellite; they are not available in all frequency bands in all regions. Ultimately, this is a quality of service issue that is unique to wireless services.

Satellite interference had become such an acute problem that a satellite industry-wide group was created to address it. The Satellite Interference Reduction Group (sIRG) members include satellite operators, service providers, broadcasters, and equipment manufacturers. Three working groups were formed within the sIRG to address different segments of the satellite industry. The Broadcast, VSAT, and Data groups are pursuing approaches to mitigate interference that are unique to their segments of the market.

To aid in identification of carriers in an interference environment the sIRG promoted the Carrier ID concept. Carrier ID would be on every carrier transmitted to the satellite. It is a small identification that may include the latitude and longitude of the transmitting station, the operator name, the contact's telephone number, or may just be the MAC address of the modulator. There are a few rules that have been created by the sIRG for the implementation of Carrier ID, these are:

- The ID must be read in the clear, by a properly configured Carrier ID receiver, even if the referenced carrier is encrypted.
- The Carrier ID must be transmitted in an industry accepted format, so that the number and type of Carrier ID receivers are kept to a minimum.
- The Carrier ID insertion must have a minimal effect on the data carrier overhead, efficiency, Es/No, phase noise and other carrier quality measurements.

The sIRG has suggested a mandate that by January 1, 2015, all new equipment that transmits a satellite carrier will have Carrier ID capability. The Broadcast group within the sIRG has agreed to implement a procedure for injection of the Carrier ID. Their proposal is that the ID will be injected in the Network Info Table (NIT) frame on the video encoder for MPEG transport streams. There is an issue with this approach, namely that when a carrier with the NIT ID enabled is experiencing interference, the NIT is no longer able to be read. The sIRG is searching for techniques to address installed legacy equipment for VSAT and data modems. The challenge here is with the multitude of different products from different manufacturers.

As a result of these industry initiatives, Comtech EF Data developed a technology called MetaCarrier® that is used to embed and detect Carrier ID on video and data satellite carriers. The Meta prefix is used in its meaning of a carrier used to describe another carrier. In this case, MetaCarrier means that we have a separate carrier that contains information, which is used to describe another single carrier, a group of carriers, or a relay, such as a satellite transponder, or terrestrial wireless relay. What is unique is that the MetaCarrier is embedded using spread spectrum techniques within the carrier(s) or relay, without adding appreciable noise to the carrier(s) or relay.

The MetaCarrier technology overlays the very low data rate Carrier ID data in a spread spectrum carrier, onto the carrier that it is referencing, Figure 1.

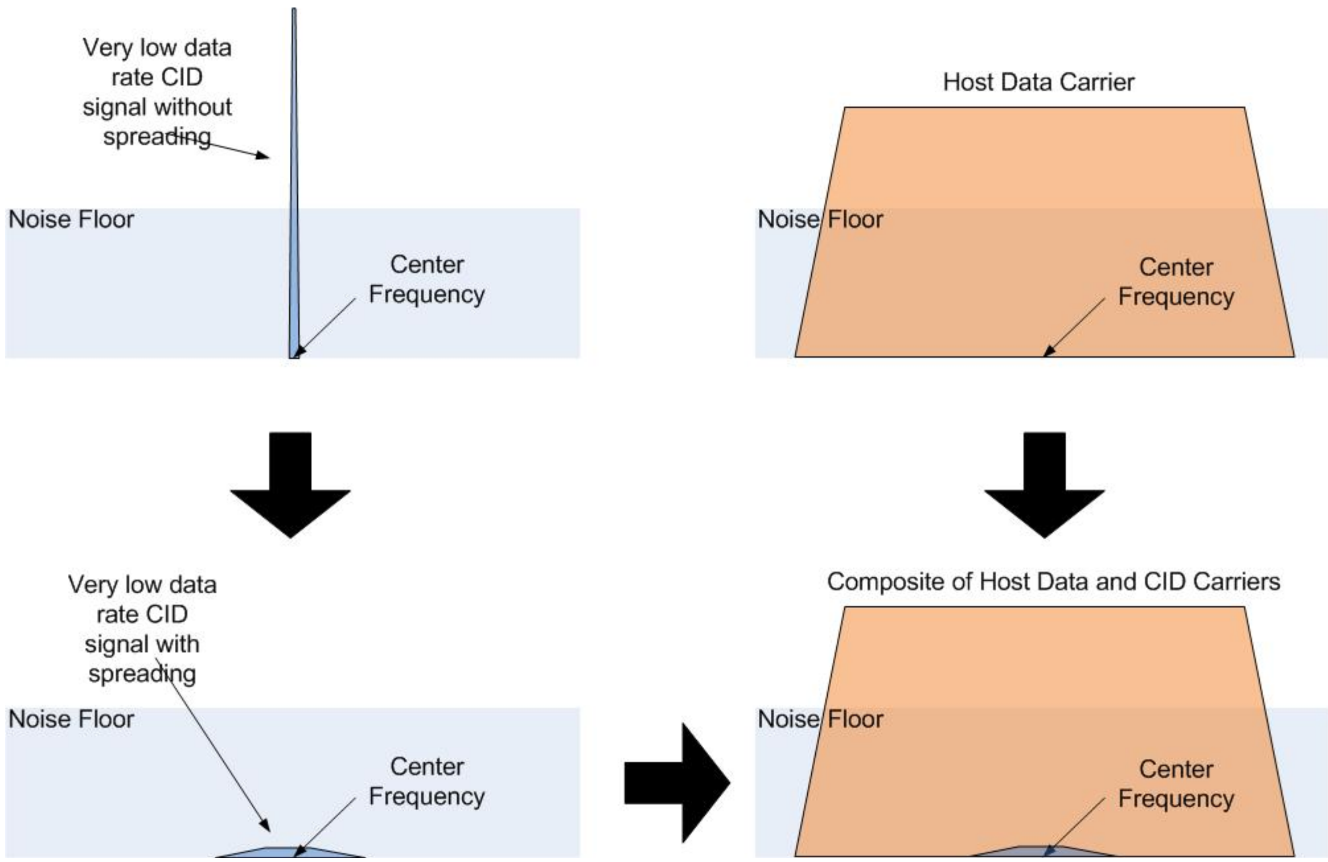

Figure 1, MetaCarrier Overlay

The MetaCarrier technology meets sIRG's Carrier ID requirements:

The ID is a small string of bytes that include lat/long, operator name, contact telephone number, etc.	√
The Carrier ID must be read in the clear, by a properly configured Carrier ID receiver, even if the referenced carrier is encrypted.	√
The Carrier ID must be transmitted in an industry accepted format, so that the number and type of Carrier ID receivers are kept to a minimum.	√
The Carrier ID insertion must have a minimal effect on the data carrier overhead, efficiency, Es/No, phase noise and other carrier quality measurements.	√

It should be noted at this point that this technology has been developed and tested in the field. Products resulting from this technology are available. In addition, the DVB Forum has endorsed a Carrier ID standard that is based on the MetaCarrier to a great extent. There are slight modifications to the initial implementation as a result of the DVB standardization effort, primarily at higher order modcods where the MetaCarrier will be injected at lower power. The European Telecommunications Standards Institute has also adapted the technology on 29 May 2013 with standard ETSI TS 103 129. Products with these changes are available from Comtech EF Data starting the second calendar quarter of 2013.

Carrier ID Using MetaCarrier Technology

Comtech EF Data expanded on the implementation requirements for Carrier ID for the embedding of the ID and the detection of the ID using our MetaCarrier technology. For the earth station sites that have a MetaCarrier embedder, the embedder must automatically:

- Detect the center frequency and bandwidth of the user's carrier
- Require no user configuration
- Select the optimum spreading for the modulated MetaCarrier

For the sites with MetaCarrier decoders, the decoder must be able to scan a full transponder under the control of an external system (Glowlink, Monics, Siemens, etc.). The MetaCarrier decoder must be able to:

- Accept a center frequency and bandwidth, either from an external system or a manual, local entry
- Acquire the MetaCarrier
- De-spread and demodulate the MetaCarrier to output the Carrier ID.

A decoded Carrier ID may be in the format of Figure 2.

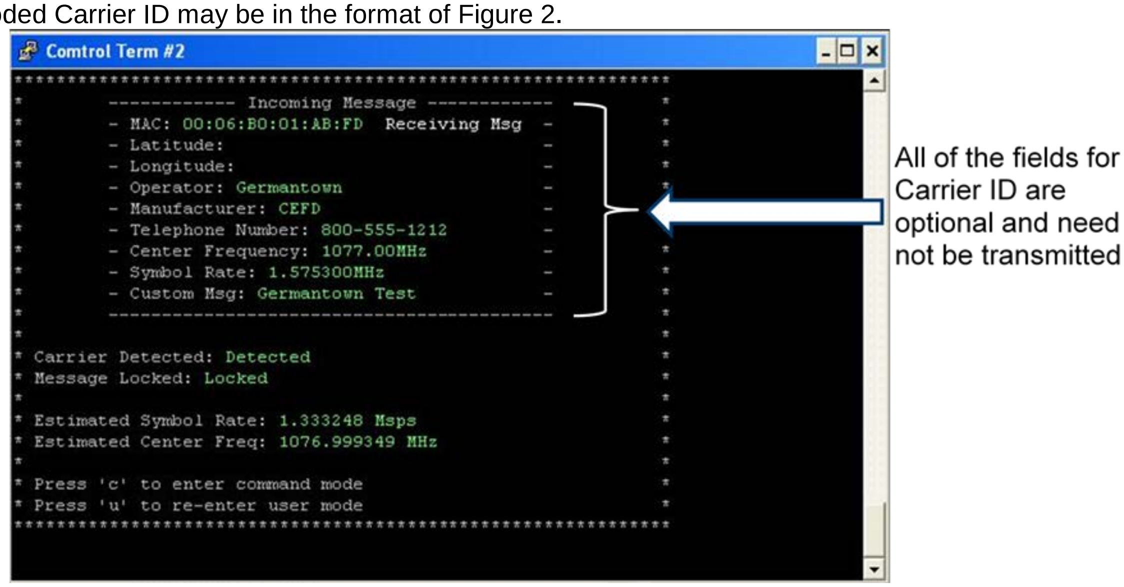

Figure 2, Decoded Carrier ID Format

The implementation of Carrier ID using MetaCarrier embedders and detectors are illustrated in Figures 3 and 4. In Figure 3, showing an SCPC network, the Carrier ID embedders are in line with the modem, connected between the IF port of the modem and the RF terminal. The site receiving the Carrier IDs via MetaCarrier does not have to be the site receiving traffic.

Similarly, in an implementation of Carrier ID in a Satellite News Gathering (SNG) application as shown in Figure 4, the Carrier ID embedder could be an external device or firmware enabled on the modulator.

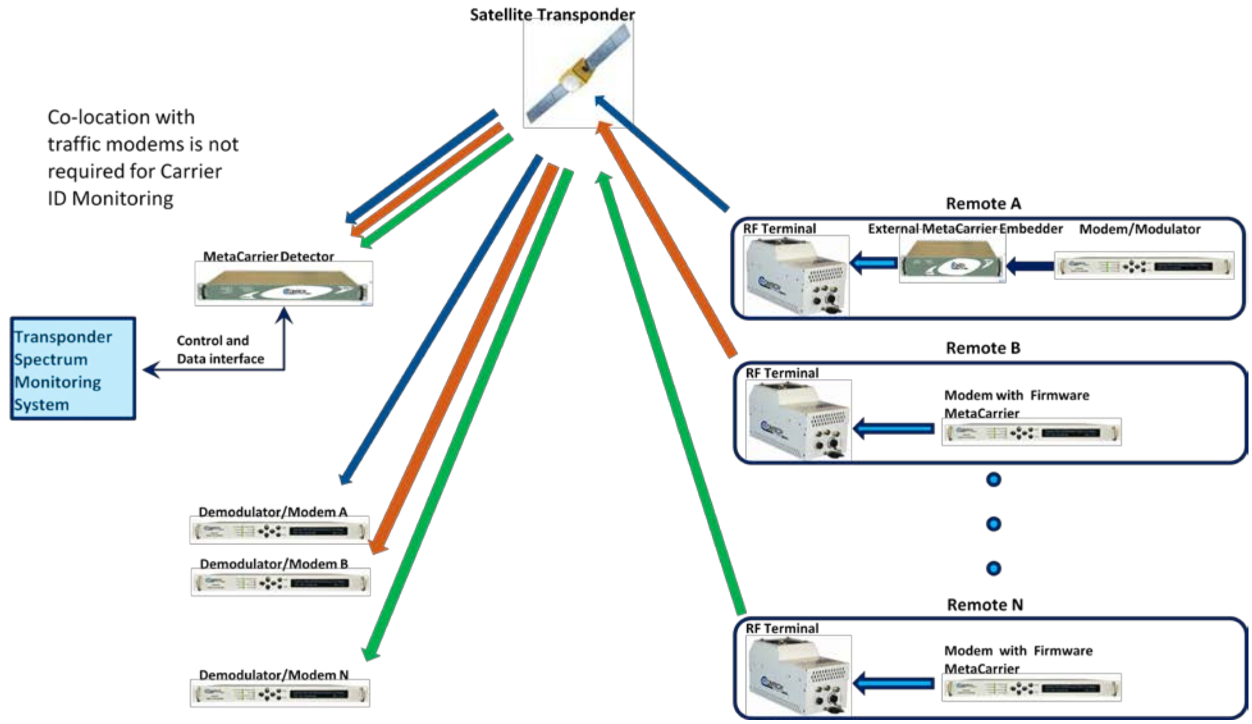

Figure 3, Carrier ID Implementation Topology – SCPC Network

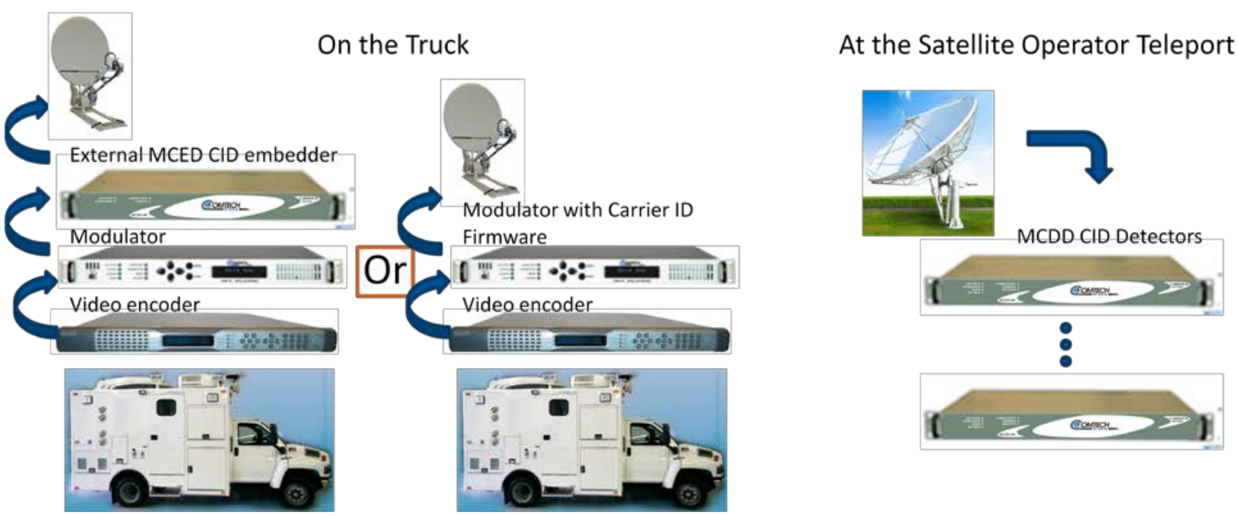

Figure 4, Carrier ID Implementation Topology – SNG Video

The MetaCarrier approach to Carrier ID has a minimal, almost insignificant impact on the carrier that it references. It uses power from the referenced carrier and its impact is more pronounced with small symbol rate carriers. However, even with a 224 ksps (kilo symbol per second) referenced carrier, the degradation of the referenced carrier due to the MetaCarrier is a tenth of a dB. Figure 5 shows the calculation at this symbol rate.

Carrier ID Configuration

Carrier ID Chip Factor	4,096	
CID Carrier Chip Rate	224.000	Kcps
CID Power Ratio	-22.000	dB
CID C/N	0.1	dB
Scaling Ratio	43.75%	
Power Ratio Original Data Carrier to CID Carrier	0.002760	
Noise Power including CID	0.102760	
Difference between Original Data Carrier and CID Carrier	9.9	dB
Spread Attenuation	-36.123599	dB
Spread Ratio	-3.590219	dB
Spread Correction	-39.713819	dB
Degraded C/N	9.99536371	dB
User Input Required		

Degradation Output

Input C/N	10.0000	dB
Degradation due to CID Power Attenuation	-0.0120	dB
Degradation due to CID Carrier as Noise	-0.1183	
Output C/N	9.8698	dB
Output Eb/No	12.8801	dB
Total Degradation	-0.1302	dB

Figure 5, Carrier ID Power Spectral Density Reduction Calculator

Certainly the utility of Carrier ID is when the traffic carriers are in severe interference. In this situation the goal is to resolve the Carrier ID from both the carrier of interest and the interfering carrier. The MetaCarrier technology approach is robust enough to extract the Carrier ID from both carriers. The image on the spectrum analyzer in Figure 6 shows two carriers each with a MetaCarrier, and not interfering with each other. In the equipment rack are two modems; one with an external MetaCarrier Carrier ID embedder, the other with an internal, firmware based MetaCarrier Carrier ID embedder. The external embedder has one red LED indicating that a GPS source is not present. One can see that the demodulator LEDs are lit green, indicating that traffic is passing. On the top of the rack is a MetaCarrier Carrier ID detector that is locked on the MetaCarrier. Below the spectrum analyzer is a PC that is connected to the MetaCarrier Carrier ID detector and displaying the Carrier ID from the modem with the firmware embedder.

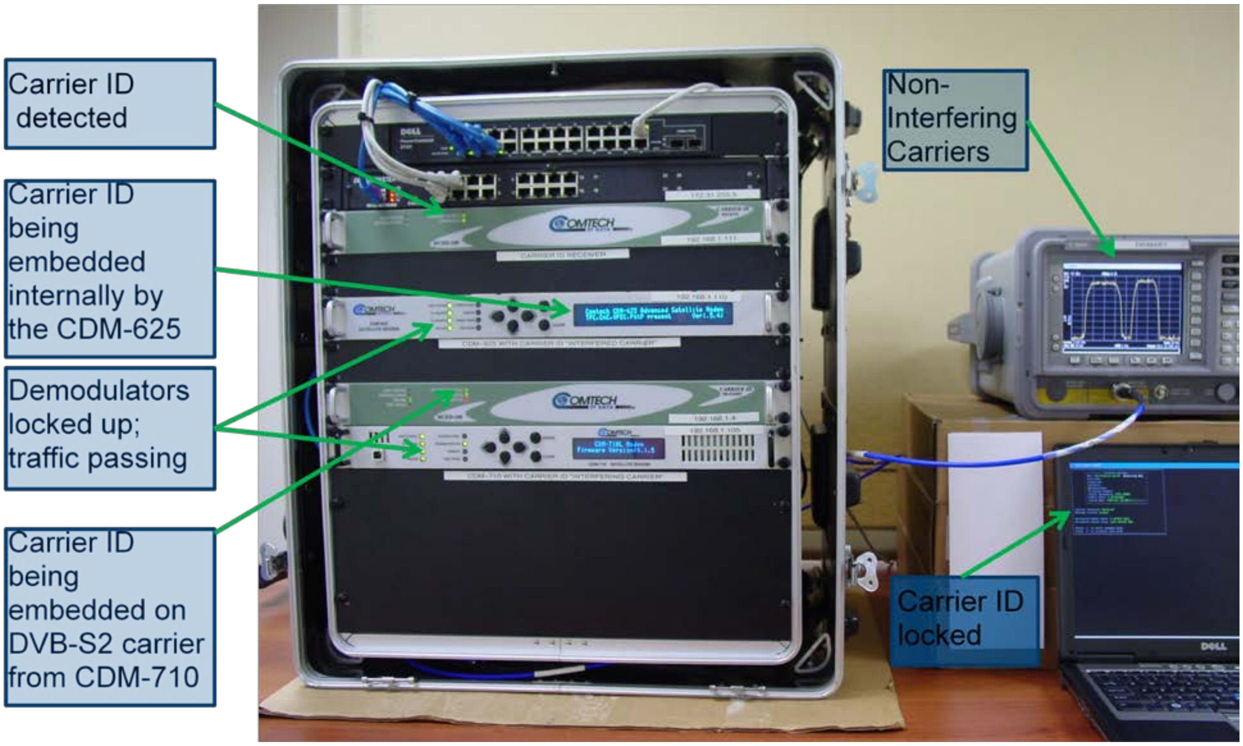

Figure 6, Non-Interfering Carriers with MetaCarriers

The non-interfering carriers were then moved closer to each other in frequency such that they almost completely overlapped. In Figure 7 one can see on the spectrum analyzer that the carriers are interfering with each other to the point that the demodulators are not locked on the modems, as indicated by the red LEDs. However, the MetaCarrier Carrier ID from the modem with the firmware version of the embedder is detected, locked, and displayed.

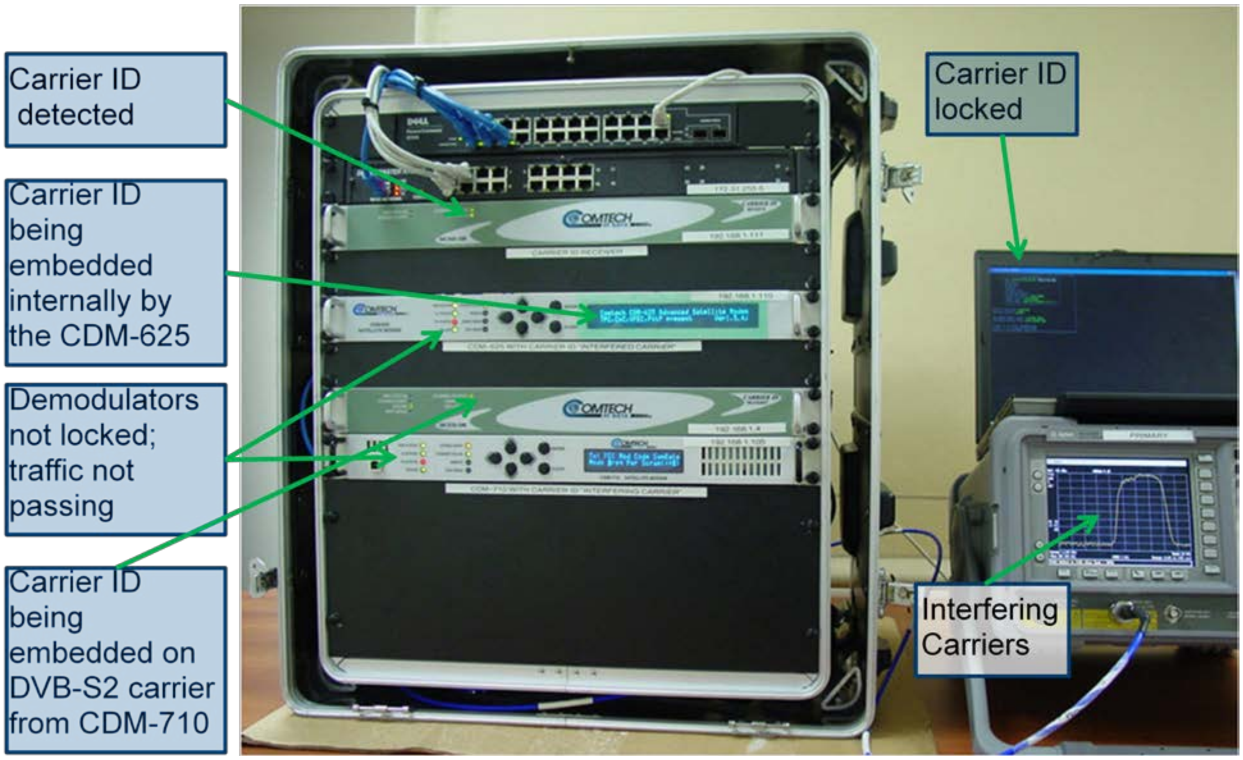

Figure 7, Interfering Carriers with MetaCarriers

With the new DVB-CID standard, the ability to have a universal identification for video and SCPC carriers is at hand with the MetaCarrier approach. This technology has been demonstrated by a number of representatives from satellite operators and is ready for industry adaptation. This technology provides the ability to significantly reduce the time to identify and clear transponders of interference sources. It will raise the level of communications quality in the industry and will help to reduce the capital and operational expense now attributed to interference.

Most in the industry who are familiar with the issue of interference agree that Carrier ID will not address all interference situations. However, there has never before been a Carrier ID technology soon ready for production that can be used with both SCPC and video carriers, and that addresses all operational and technical concerns. It is time for its implementation by the satellite industry.

For additional information, please contact:

Fred Morris
VP Global Sales Engineering
Comtech EF Data Corp.
2114 West 7th Street
Tempe, AZ 85281 USA

fmorris@comtechefdata.com