Satellite Carrier Identification

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More satellites, closely spaced, and more users of satellite communications have increased interference events on satellite systems to the point that three industry groups currently address it; the Satellite Interference Reduction Group (sIRG) ((formerly Satellite Users Interference Reduction Group (SUIRG)), the Radio Frequency Interference – End User Initiative (RFI-EUI), and the Global VSAT Forum (GVF). The members of these groups include satellite operators, service providers, broadcasters, and equipment manufacturers.

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 Long-term may be from adjacent satellites, which would be due to either lack of coordination between users, outdated or poorly designed equipment, or small mobile antennas.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 incorrect settings by 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.

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. Ultimately, this is a quality of service issue that is unique to wireless services.

The sIRG aims to expand awareness of interference within satellite industry operators, users and regulatory agencies to help stop interference and to investigate new technologies and techniques to mitigate satellite interference. The RFI-EUI was created in February, 2011 for broadcast industry customers, clients and all end users of satellite capacity to address RFI and its prevention by identification and reduction of satellite interference. The GVF was formed in 1998, to act as the representative of the satellite industry. Since then, the charter of the GVF has grown to cover standardization testing and training for the industry.

Starting in 2007, the SUIRG promoted a DVB Network Information Table (NIT) version of Carrier ID, however, there were some technical issues with that version of implementation. The issue with this approach was that when a carrier with the NIT ID enabled experienced interference, the NIT was no longer able to be read because the carrier is in an interference condition. To address that, and to aid in identification of carriers in an interference environment, the sIRG promoted an outline of a new Carrier ID concept. In its optimal form, this new Carrier ID would be on every carrier transmitted to the satellite. Like the NIT version, it is a small identification that may include the latitude and longitude of the transmitting station, the operator's name, the contact's telephone number, or may just be the MAC address of the modulator. The sIRG outline for the new Carrier ID included these rules:

- 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.

Simultaneous to sIRG issuing the Carrier ID rules, three working groups were formed within the sIRG to address different segments of the satellite industry. The Broadcast, VSAT, and Data groups pursue approaches to mitigate interference that are unique to their segments of the market. In addition, the RFI-EUI has three working groups, Carrier ID, Best Practices, Documentation and Technology, and Training & Certification. Also, the GVF has the Mutual Recognition Arrangement Working Group (MRA-WG), which oversees industry practices to assist in reduction of interference. The groups coordinate with each other to minimize the duplication of efforts.

As a result of these industry initiatives, and a challenge from Intelsat, 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.

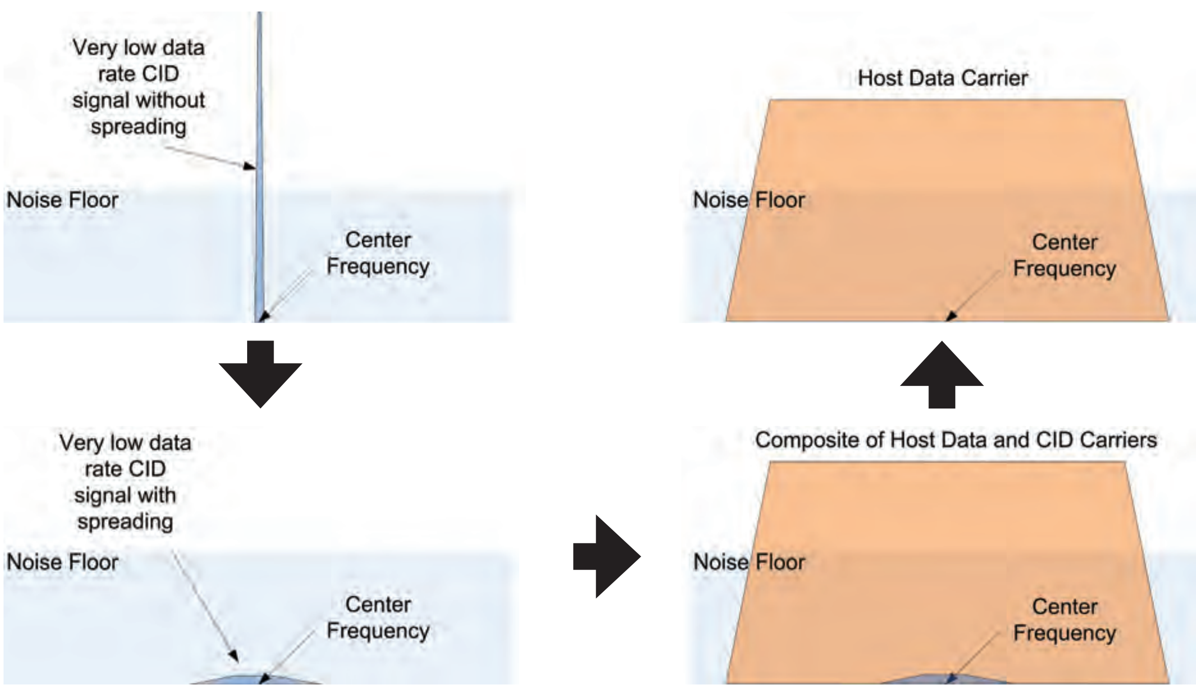


Figure 1. MetaCarrier Overlay

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.

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

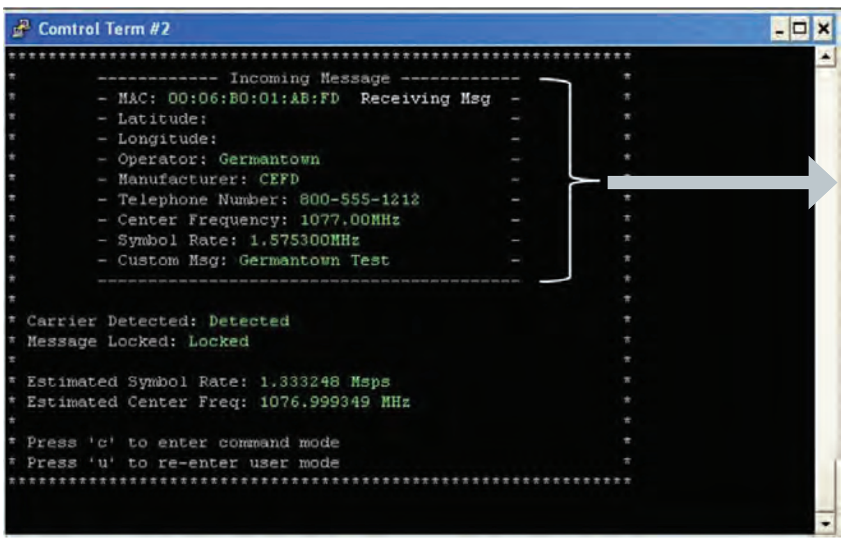
- Detect the center frequency and bandwidth of the user's carrier
- Require no user configuration
- Select the optimum spreading for the modulated MetaCarrier

It should be noted at this point that the DVB Forum has endorsed a Carrier ID standard that is largely based on the MetaCarrier technology. There are slight modifications to the initial implementation as a result of the DVB standardization efforts, primarily at higher order modulations where the spread spectrum carrier will be injected at lower power than that of lower order modulations. The European Telecommunications Standards Institute also adapted the technology on 29 May 2013 with standard ETSI TS 103 129. Products supporting this technology are available from Comtech EF Data and other vendors now.

For the sites with ETSI standard decoders, such as satellite or teleport operators, the decoder must be able to scan a full transponder under the control of an external system (Glowlink, Monics, Siemens, etc.), and 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.



All of the fields for Carrier ID are optional and need not be transmitted

Figure 2. Decoded Carrier ID Format

The implementation of Carrier ID using MetaCarrier embedding and detection are illustrated in Figures 3 and 4. In Figure 3, showing an SCPC network, the Carrier ID is embedded by the modems modulator. 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 embedding would also be firmware enabled on the modulator.

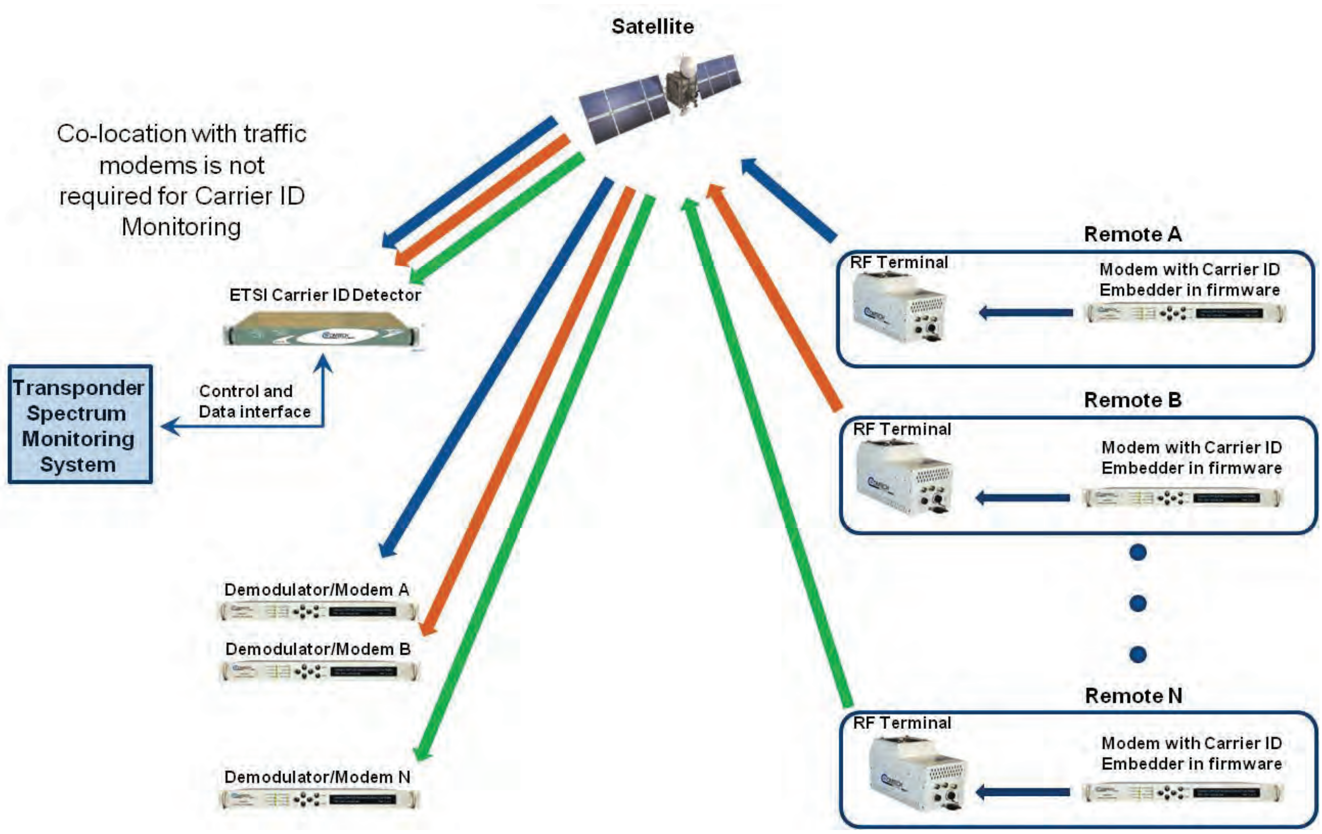


Figure 3. Carrier ID Implementation Topology – SCPC Network

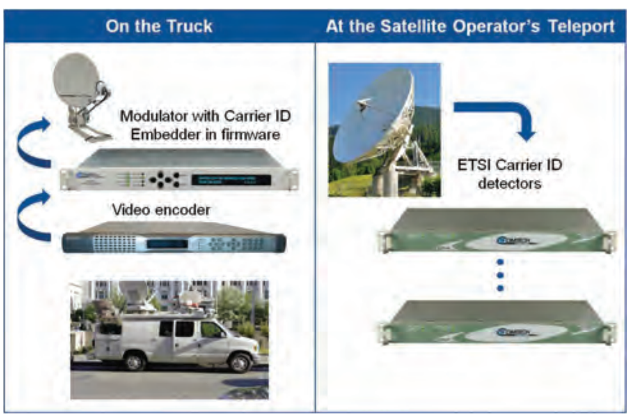


Figure 4. Carrier ID Implementation Topology – SNG Video

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.

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 8 shows two carriers not interfering with each other. In the equipment rack are two modems; one acting as an interferer and the other with an internal, firmware based MetaCarrier Carrier ID embedder. The demodulator LEDs are illuminated 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.

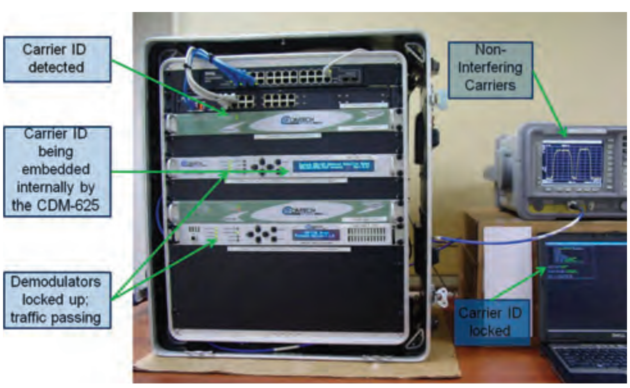


Figure 5. Non-Interfering Carriers with MetaCarriers

For the interference case, the non-interfering carriers were moved closer to each other in frequency such that they almost completely overlapped. In Figure 6, 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.

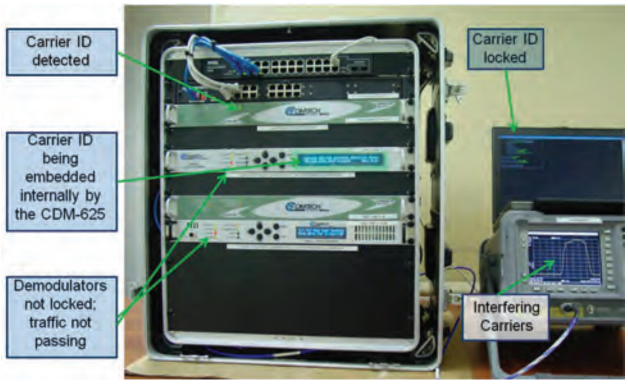


Figure 6. Interfering Carriers with MetaCarriers

With the new ETSI Carrier ID standard, the ability to have a universal identification for video and SCPC carriers is at hand. 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.

The sIRG and the RFI-EUI have suggested a mandate that by January 1, 2015, all new, installed equipment that transmit a satellite carrier should have Carrier ID capability. In addition, 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 and transmission techniques.

Most in the industry who are familiar with the issue of interference agree that the current ETSI standard 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.

Frederick Morris is VP of Sales Engineering for Comtech EF Data where he is responsible for customers' technical solutions. Previously, he was VP of Product Management & Development at Intelsat. His experience also includes senior positions at Verestar, SES Americom, Viacast Networks & Hughes. Morris holds a BSEE from the University of Connecticut and a MS, Technology Management from the University of Maryland.