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D9036 DPI – ANSI/SCTE104
Software Functional Specification

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1 Introduction

Digital Program Insertion (DPI) signaling allows downstream splicing equipment like a DCM to insert advertisements or local programs into national programs in digital domain. Triggers are typically sent to the Encoder which generate frame accurate DPI messages in the form of SCTE-35 messages to allow downstream equipment to perform splicing.

The approach to enable DPI triggers that is widely deployed is the use of GPI inputs that are generated either though an Automated system (pre-recorded content) or Manually (Live event).

The ANSI/SCTE 104 standard and the Recommended Practice SMPTE RP 2010 have emerged as a better mechanism to enable DPI triggers using messages inserted in the VANC interface. The D9036 Modular Video Input (MVI) module supports extraction of the SMPTE-RP 2010 message data so that it can be passed to the Modular Video Codec (MVC) card for processing based on its configuration parameters.

This document provides detailed information on the implementation of SCTE-104 specification in D9036 Encoder.

2 SCTE-104 Functional Structure

As stated above, the SCTE-104 messages basically describe the contents of the SCTE-35 message that the encoder needs to generate to enable splicing downstream.

2.1 SCTE-104 support on D9036 GUI

SCTE-104 can be enabled and configured in the D9036 GUI via the SCTE 104 tab in the DPI section of the VSE. Please note that the DPI section used to be a single tab for the VSE but it is now a hierarchical section under the VSE on the left hand menu.

It should be noted that SCTE-104 can be used instead of or in conjunction with contact closure-based splicing control. There would be no interaction between the two input types, with the exception of parameters that affect the entire DPI engine, such as bit rate and bandwidth reservation. For example, the total bit rate of packets triggered by either method cannot exceed the specified bit rate. The transport packets generated via both methods will be output on the same PID.

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As indicated by Figure 1, preconditioning for H.264 in the form of IDR insertion at splice start or stop points is supported.

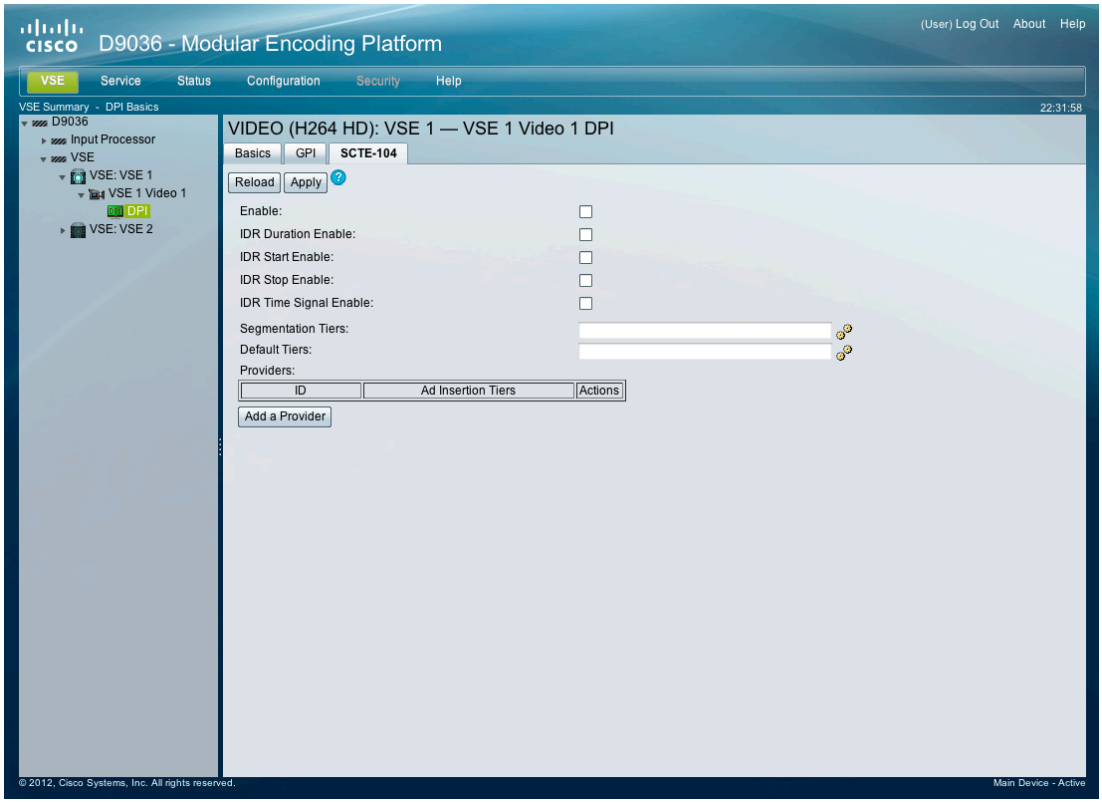


Figure 1: SCTE-104 Tab in D9036 GUI

An overview of the parameters on the GUI is provided below:

- **Enable**
  - Enable or disable SCTE 104 support
  - Default disable

The following parameters refer to pre-conditioning in H.264 in the form of IDR insertion at splice start or stop points. Note that all insertion times are rounded down to the nearest frame.

- **IDR Duration Enable**
  - Insert an IDR at the frame calculated by adding the duration to the PTS of a splice insert "start" message

- **IDR Start Enable**
  - Insert an IDR at the frame corresponding to the PTS specified by a splice insert "start" message

- **IDR Stop Enable**
  - Insert an IDR at the frame with PTS specified by a splice insert "stop" message

- **IDR Time Signal Enable**
  - Insert an IDR at both:
    - the frame with PTS specified by a time signal message
    - the frame calculated by adding the duration specified in a segmentation descriptor (if present) to the time signal PTS

The following parameters refer to the use of authorization tiers that provide control over access of splicing triggers opportunities downstream. Please refer to Section 3.2 for further information.

- **Segmentation Tiers**
  - User can select up to eight tiers
  - Range 0 to 151
  - Enable/disable for each tier

- **Default Tiers**
  - User can select up to eight tiers
  - Range 0 to 151
  - Enable/disable for each tier

- **Provider Tiers**
  - For each of 30 provider avail IDs, the user can select a set of up to 8 tiers
  - Range 0 to 151
  - Enable/disable for each tier
  - One set of tiers will be selected based on the associated provider avail ID

2.2 Overview of DPI Application

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2.2.1 Filtering for SMPTE-RP 2010

The MVI DPI application will run on the MVI-VBI PowerPC and will use the VANC kernel driver to extract the incoming message data from the VANC. The VANC driver will be used to extract the SMPTE-RP 2010 messages from the incoming video frame by filtering VANC packets with the **DID set to 0x41 and SDID set to 0x07**.

Each video frame can contain one SMPTE-RP 2010 message which can contain no more than one complete SCTE-104 message. Each message can be comprised of one or more packets. The total incoming SMPTE-RP 2010 message size per frame should not exceed 2000 bytes. In case that happens, the message will be dropped and an alarm will be raised.

2.2.2 Frame Synchronization Issues

The DPI application must not drop or repeat SMPTE-RP 2010 message information during frame synchronization events, specifically, frame skip and frame repeat events.

If a frame containing a SMPTE-RP 2010 message needs to be skipped to maintain synchronization between the input and output video streams, the DPI application must ensure that all message content of the skipped frame is copied into the next frame. If the next frame also contains SMPTE-RP 2010 message content, then both messages will be sent in the same frame.

Each SMPTE-RP 2010 packet is not necessarily carried to MVC along with the same picture data. Each output packet will be time-stamped and the time stamp will be used on the MVC to correlate the SMPTE-RP 2010 packet back to corresponding video frame.

The order of the SMPTE-RP 2010 messages must be maintained at all times. This means if there are two messages to be sent in one frame, the oldest message must be inserted first.

If a frame containing a SMPTE-RP 2010 message needs to be repeated to maintain synchronization between the input and output video streams, the DPI application will not send the original SMPTE-RP 2010 message content in the second (repeated) frame.

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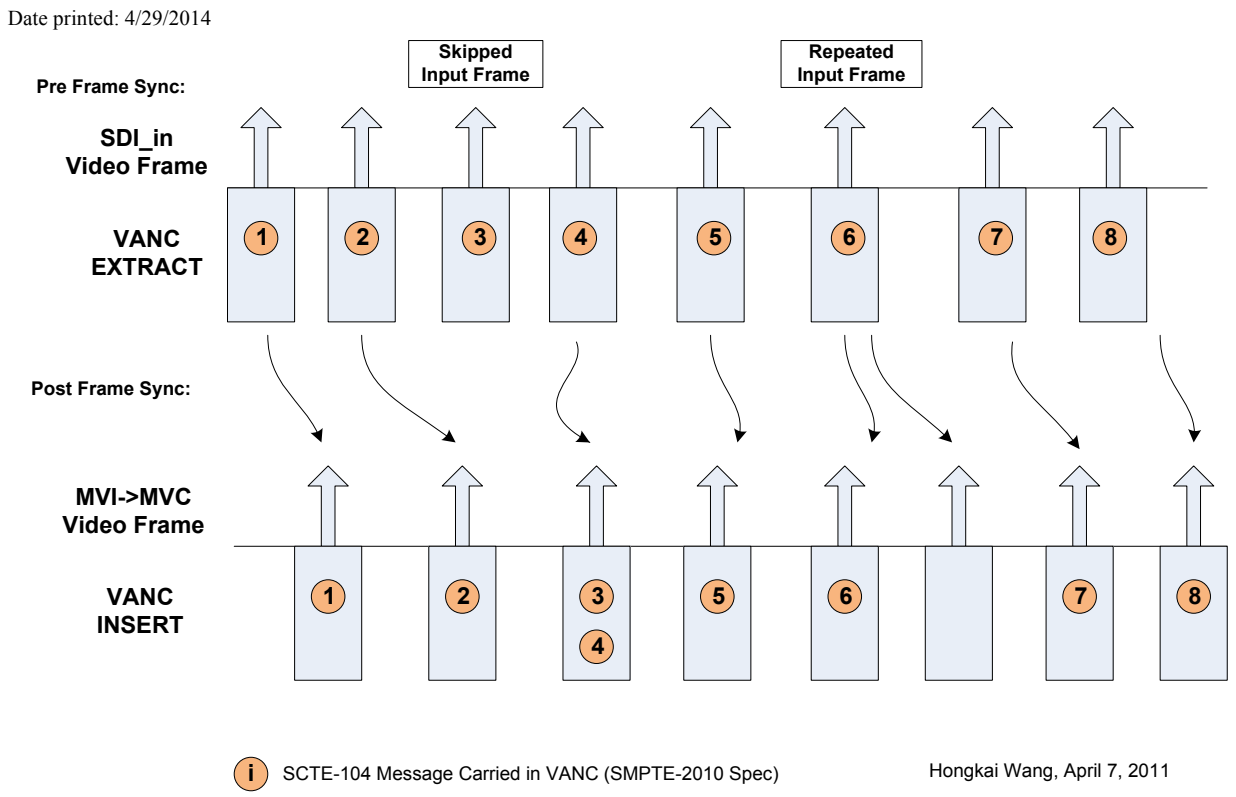


Figure 2: Frame synchronization skip/repeat behavior

Note that all SMPTE-RP 2010 messages received by the MVI DPI application will be forwarded to the MVC via the VANC tunnel. The MVI will not filter and/or drop duplicate messages.

3 SCTE-104 Functional Structure

3.1 SCTE-104 Supported Messages

The SCTE-104 standard contain numerous operations but the following messages are the ones supported in D9036:

OpID	Operation Name
0x0101	splice_request_data()
0x0104	time_signal_request_data()
0x0109	insert_DTMF_descriptor_request_data()
0x010A	insert_avail_descriptor_request_data()
0x010B	insert_segmentation_descriptor_request_data()
0x010F	insert_tier_data

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Every SCTE-104 message should contain either a `splice_request_data()` section (OpID 0x0101) or a `time_signal_request_data()` section (OpID 0x0104) followed with zero or more descriptors (OpID 0x109, 0x010A, 0x010B, 0x010F). In D9036, the SCTE 104 message may include up to 2 segmentation, 4 avail and 1 DTMF as well as 8 tier authorization descriptors.

Please note that:

- Any descriptors preceding the first normal request will be discarded.
- In the case where multiple descriptor requests of the same type are included in the SCTE-104 message, the D9036 will process:
  - The first DTMF descriptor request
  - The first two segmentation descriptor requests
  - The first four provider_avail_ids from avail descriptor requests (which can each contain multiple provider_avail_ids).
  - The first eight insert_tier_data requests

Within these limits, all of these descriptors can be used in the same message. Exceeding any limits will raise an alarm, but the rest of the message will still be processed.

3.1.1 "Splice_request_data()" message

Please refer to Table 8-5 – in Reference [1].

```
splice_request_data() {
    splice_insert_type
    splice_event_id
    unique_program_id
    pre_roll_time
    break_duration
    avail_num
    avails_expected
    auto_return_flag
}
```

When IDR insertion on splice start or stop is enabled and splice_insert_type is spliceStart_normal or spliceEnd_normal, pre_roll_time should be at least 200 ms. Shorter times may prevent successful insertion. When splice_insert_type is spliceStart_immediate or spliceEnd_immediate, IDR insertion will be performed on a best-effort basis as close as possible to the target frame. IDR insertion is not supported when splice_insert_type is splice_cancel.

3.1.2 “Time_signal_request_data()” message

Please refer to Table 8-23 – in Reference [1].

```
time_signal_request_data() {
    pre-roll_time
}
```

When IDR insertion on time signal is enabled, pre-roll_time should be at least 200 milliseconds. Shorter times may prevent successful insertion.

3.1.3 “Insert_DTMF_descriptor_request_data()” descriptor message

Please refer to Table 8-28 – in Reference [1].

```
insert_DTMF_descriptor_request_data() {
    pre-roll
    dtmf_length
    for(i=0; i<dtmf_length; i++) {
        DTMF_char
    }
}
```

This request creates an image of the DTMF descriptor defined in SCTE 35-2004. DTMF_char should contain only the values ‘0’ – ‘9’, ‘A’ – ‘D’, ‘#’ and ‘*’, although this is not enforced by the D9036.

One specific note about this descriptor. The pre-roll field found in this descriptor is intended to be the same value as that used for the associated splice_request. The DTMF descriptor allows for tenths of a second resolution, and the splice_request allows millisecond resolution. One should ensure that both requests use the same pre-roll value to provide a consistent program insertion on both analog and digital systems.

3.1.4 “Insert_avail_descriptor_request_data()” descriptor message

Please refer to Table 8-26 – in Reference [1].

```
insert_avail_descriptor_request_data() {
```

```
    num_provider_avails
    for (i = 0; i < num_provider_avails; i++) {
        provider_avail_id
    }
}
```

Each provider_avail_id value will create a separate avail_descriptor in the SCTE-35 output. As mentioned above, a maximum of four avail_descriptors per SCTE-35 message will be output.

3.1.5 "Insert_segmentation_descriptor_request_data()" descriptor message

Please refer to Table 8-29 – in Reference [1].

```
insert_segmentation_descriptor_request_data() {
    segmentation_event_id
    segmentation_event_cancel_indicator
    duration
    segmentation_upid_type
    segmentation_upid_length
    segmentation_upid
    segmentation_type_id
    segment_num segments_expected
    duration_extension_frames
    delivery_not_restricted_flag
    web_delivery_allowed_flag
    no_regional_blackout_flag
    archive_allowed_flag
    device_restrictions
}
```

The maximum length of segmentation_upid() within a segmentation descriptor request is 64 bytes.

3.1.6 "Insert_tier_data()" descriptor message

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```
insert_tier() {
    tier
}
```

insert_tier_data sets the tier field of the SCTE-35 splice_info_section. If multiple requests are received, the first will be used as the tier field value.

An insert_tier_data request will also insert an authorization_tier descriptor with an authorization index equal to the lower 8 bits of tier. Additional requests will add more authorization index values to the same descriptor, to a maximum of 8. This will override any other means of signaling authorization tiers as discussed in Section 3.2.

3.2 Authorization Tiering Support

As introduced above, authorization tiers approach is a very powerful means to allow access/denial control capabilities over splicing triggers and content segments opportunities. The ad insertion tier descriptor is controlled indirectly via the GUI and the contents of other descriptors.

In the following, we provide some details on how different tiering mechanisms through the D9036 GUI. The SCTE104 authorization tier tables will be maintained on MCB and downloaded to MVC via configuration channel:

- Provider mapping table (provider tiers)
- Segmentation tiers
- Default tiers

All tables are maintained on per VSE/DPI stream basis. Eight (8) tiers are assumed. Tier values are 0...151, with explicit enable/valid/used control.

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3.2.1 Providers Tiers

Provider tiers will be used if the message contains an avail descriptor. If the provider avail ID in the avail descriptor matches an entry in the ID column, the ad insertion tier descriptor will contain the corresponding set of tiers. As shown in Figure 3, an avail descriptor request with ID 95 would result in an ad insertion tier descriptor with values 23 through 27

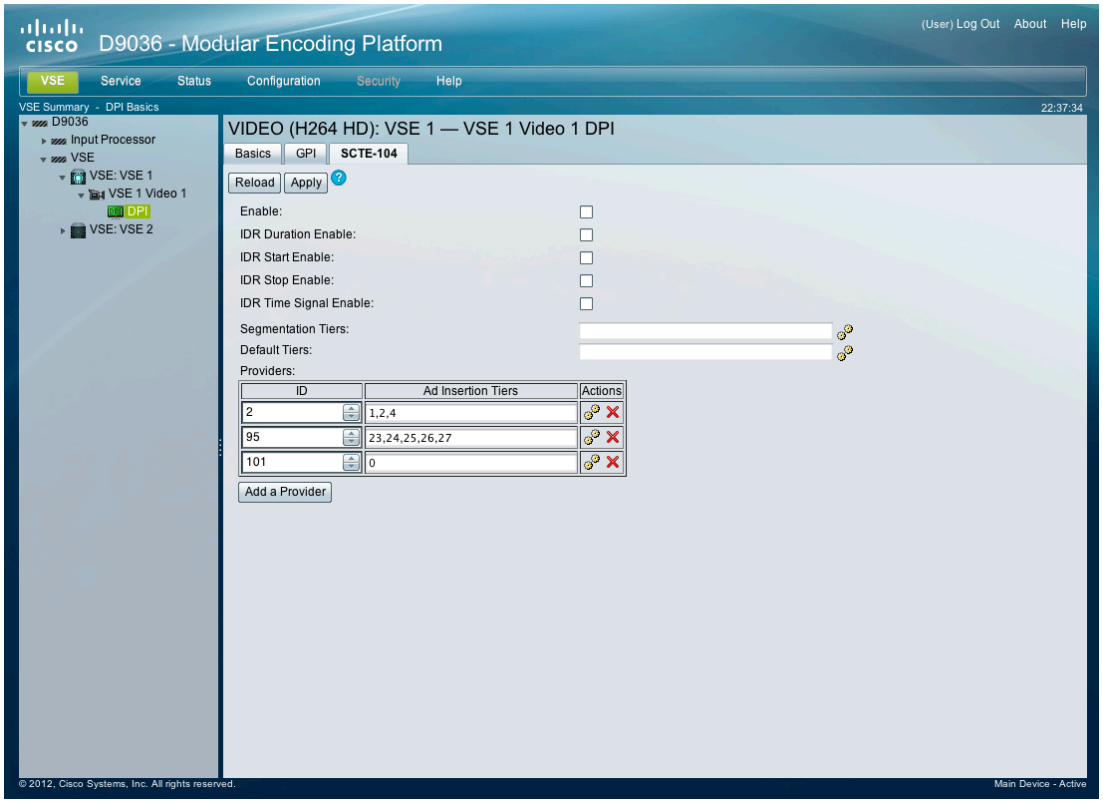


Figure 3: Providers Tiers example

3.2.2 Segmentation Tiers

The segmentation descriptors provide the following capabilities:

- Mark events (program and chapter) start and end times for downstream equipments
- Marking programs for VOD recording
- Marking national ads section to disable fast-forward in OnDemand playback
- Marking programs/ads/segments for regional blackout

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Segmentation tiers will be used if the message contains a segmentation descriptor.

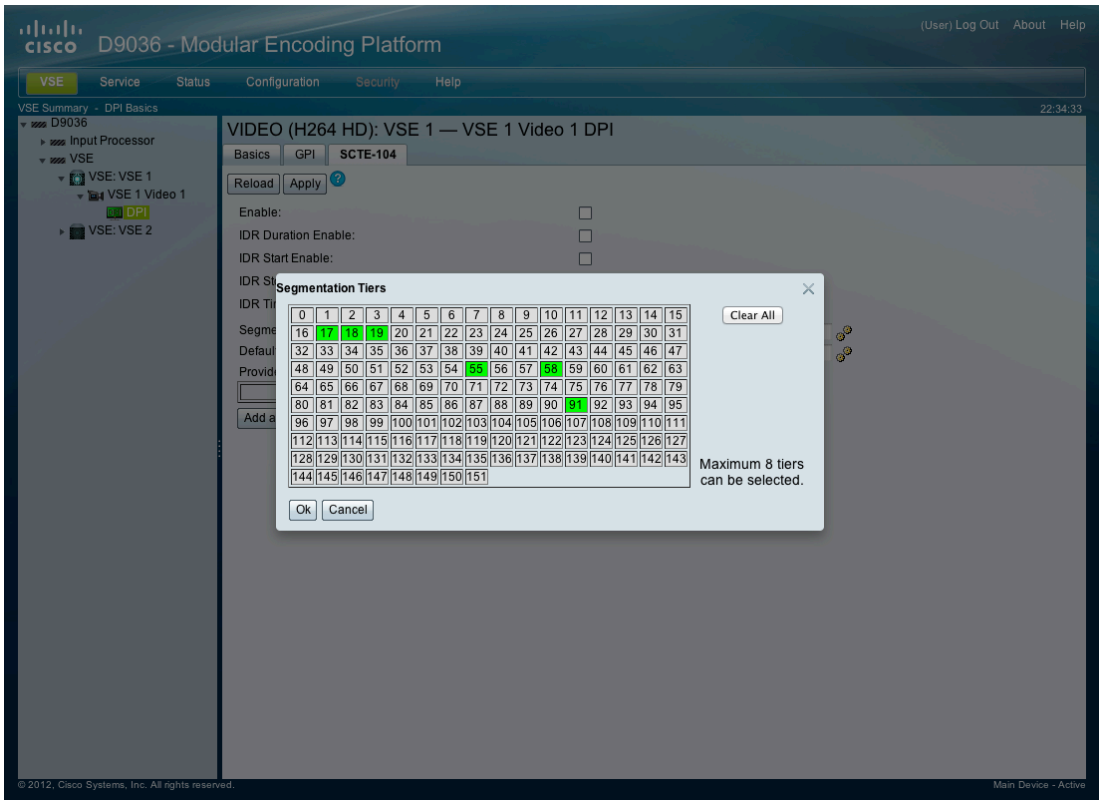


Figure 4: Segmentation Tiers example

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3.2.3 Default Tiers

The Default tiers will be used if the SCTE-104 message:

- does not contain a segmentation descriptor or
- contains an avail descriptor with an ID that does not appear in the provider table, or
- does not contain any avail descriptors

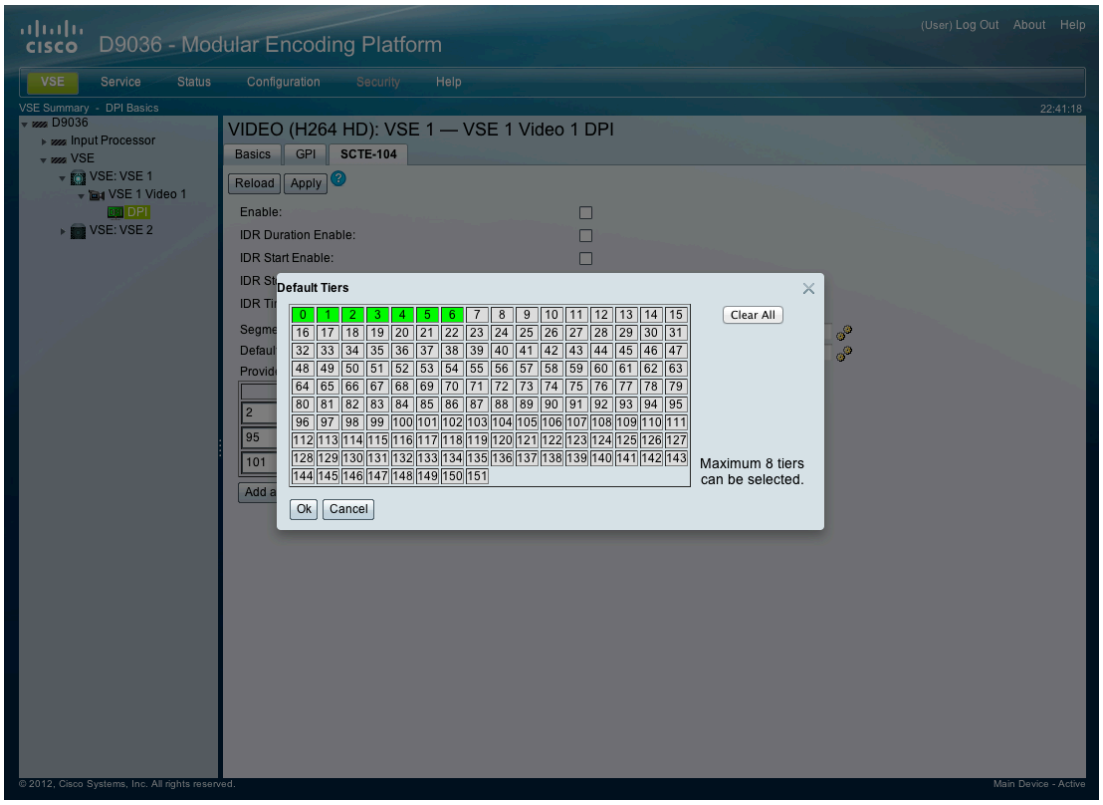


Figure 5: Default Tiers example

4 Mapping to SCTE-35

In the following, some of the comments related to mapping of SCTE-104 data to SCTE-35 messages are provided:

- Any type of tiers, defined in figures above (segmentation, provider, default) is considered enabled when at least one tier in table is enabled
- Insert segmentation descriptor request in SCTE-104 message will map into segmentation descriptor and zero or one authorization tier descriptor (as defined in table below) in SCTE-35 message.

- Insert avail descriptor request in SCTE-04 message will map into one or multiple provider avail id descriptors based on number of provider IDs in request loop and zero or one authorization tier descriptor (as defined in table below) in SCTE-35 message.
- If multiple requests to insert segmentation descriptor are present in SCTE-104 message, multiple segmentation descriptors will be sent in SCTE-35. Zero or one authorization tiers descriptor (as defined in table below) will be sent.
- If multiple requests to insert provider avail ID descriptor are present in SCTE-104 message, multiple avail descriptors will be sent in SCTE-35. Zero or one authorization tiers descriptor, based on first provider_avail_id in loop in first message (as defined in table below) will be sent.
- Default tiers are sent (if enabled) when request to insert avail descriptor is present in SCTE-104 message and it can't be resolved/mapped to any of provider tiers rows or neither request is present in SCTE-104 message.

<table>
<tr><td colspan="2">SCTE104</td><td colspan="5">SCTE35</td></tr>
<tr><td>#segmentation requests</td><td>#provider requests/# provider IDs</td><td>Segmentation descriptor</td><td>Provider descriptor</td><td colspan="3">Tier Authorization descriptor</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">0/0</td><td rowspan="2">not applicable</td><td rowspan="2">not applicable</td><td>default tiers enabled: yes</td><td colspan="2">send descriptor with default tiers</td></tr>
<tr><td>default tiers enabled: no</td><td colspan="2">do not send descriptor</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">0/0</td><td rowspan="2">descriptor based on request data</td><td rowspan="2">not applicable</td><td>segmentation tiers enabled: yes</td><td colspan="2">send descriptor with segmentation tiers</td></tr>
<tr><td>segmentation tiers enabled: no</td><td colspan="2">do not send descriptor</td></tr>
<tr><td>N(N > 1)</td><td>0/0</td><td>N descriptors based on request data</td><td>not applicable</td><td colspan="3">single descriptor as described in previous row</td></tr>
<tr><td rowspan="4">0</td><td rowspan="4">1/K(K>=1)
K – number of provider IDs carried in provider request loop</td><td rowspan="4">not applicable</td><td rowspan="4">K descriptors based on provider request loop</td><td rowspan="2">matching row found based on provider id in first loop: yes</td><td>provider tiers enabled: yes</td><td>send descriptor with provider tiers</td></tr>
<tr><td>provider tiers enabled: no</td><td>do not send descriptor</td></tr>
<tr><td rowspan="2">matching row found based on provider id in first loop: no</td><td>default tiers enabled: yes</td><td>send descriptor with default tiers</td></tr>
<tr><td>default tiers enabled: no</td><td>do not send descriptor</td></tr>
<tr><td>0</td><td>M (M>1)/K(K>=1)
K – total number of provider IDs carried in M requests</td><td>not applicable</td><td>M x K descriptors based on provider request loops in individual messages</td><td colspan="3">Single descriptor as described in previous row</td></tr>
<tr><td>N (N >= 1)</td><td>M (M >= 1)/K(K>=1)
M – total number of provider IDs carried in M requests</td><td>N descriptors based on request data</td><td>M x K descriptors based on provider request loops in individual</td><td colspan="2">segmentation tiers enabled: yes</td><td>send descriptor with segmentation tiers</td></tr>
</table>

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			messages	segmentation tiers enabled: no	do not send descriptor

5 SCTE-104 Logging and Alarms

Any SCTE-104 message received will trigger an informational alarm with an associated hex dump of the incoming message, subject to the string length limits of the alarm subsystem.

The first provider_avail_id of the first insert_avail_descriptor_request_data opID for each multi-op message will trigger an informational alarm containing the value of the provider_avail_id.

All SCTE-104 message activity will also be written to a separate log file by VEnc. The mechanism by which this will be done has not yet been determined.

5.1 SCTE-104 Alarms

Event	Severity	Message
SCTE 104 message received	Info	"SCTE 104 – Received message ## ## ## ## …"
First provider avail ID received (per message)	Info	"SCTE 104 – Received provider avail ID ##"
Unsupported opID	Major	"SCTE 104 – Unsupported opID ##"
time_type != 0	Major	"SCTE 104 – time_type must be 0"
protocol_version or SCTE35_protocol_version != 0	Major	"SCTE 104 – Unsupported protocol version specified"
segmentation_upid_length > 64	Minor	"SCTE 104 – segmentation_upid truncated"
Other syntax error	Major	"SCTE 104 – Error in opID ##"

Please note that as indicated in the table above, OpIDs which are not supported will cause an alarm to be raised. Multiple normal requests per SCTE-104 message will produce multiple SCTE-35 messages. Given the limits imposed on the SCTE-104 message, it is expected that the resulting SCTE-35 messages will consist of no more than two transport packets each.

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1. References

[1] ANSI_SCTE 104, "Automation System to Compression System Communications Applications Program Interface (API)", 2004

2. Glossary

The following list describes acronyms and definitions for terms used throughout this document:

ANC: Ancillary Data (SMPTE 291M)

DID: Data ID (SMPTE 291M)

DPI: Digital Program Insertion

DTMF: Dual Tone Multi Frequency

ES: Elementary Stream

PID: Packet ID

PMT: Program Map Table

PRD: Product Requirement Document

PTS: Presentation Time Stamp

SBF: Service Board Framework

SDID: Secondary Data ID (SMPTE 291M)

SE: Stream Encoder

TP: Transport Packet

TS: Transport Stream

VANC: Vertical Ancillary Data

VSE: Virtual Service Encoder

End of Document

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