OPTIMIZING INTERNET CONTENT DELIVERY USING PROGRAM SELECTION

Ciro Noronha, Ph.D.
Cobalt Digital

Agenda

- Problem Definition
- RIST TR Status
- Technical Discussion
- Example use cases
- Testing Results

Problem Definition

- Even though RIST is content-agnostic, it is commonly used to carry MPEG Transport Streams.
- MPEG Transport Streams typically include multiple components, multiplexed into a single flow:
  - One or more programs, which may include a set of related media
  - A program may include video elements, audio elements, and various types of data elements
- A RIST receiver may not require all the components of a Transport Stream:
  - It may only require a subset of the programs present in the Transport Stream
  - It may only require a subset of the elements present in a program
- If the RIST receiver can signal its requirements to the sender, bandwidth can be saved by only transmitting what is needed.

RIST TR Status

- TR-06-1: RIST Simple Profile (last updated in 2020)
- TR-06-2: RIST Main Profile (last updated in 2024)
- TR-06-3: RIST Advanced Profile (last updated in 2024)
- TR-06-4: RIST Ancillary features
  - TR-06-4 Part 1: Source Adaptation (published in 2022)
  - TR-06-4 Part 2: Use of Wireguard in RIST (published 2023)
  - TR-06-4 Part 3: RIST Relay (published 2023)
  - TR-06-4 Part 4: Decoder Synchronization (published 2024)
  - TR-06-4 Part 5: Multicast Discovery (published 2023)
  - TR-06-4 Part 6: Transport Stream Program Selection (published July 2024)

Solution Framework

- The problem can be divided into two parts:
  1. How does the receiver "tell" the sender what it requires?
  2. How does the sender transmit a **compliant** stream with just the parts required by the receiver?
- ISO/IEC 13818-1 compliance requirements (simplified):
  - Transport Streams with a single time base can be VBR (typically, *Single Program Transport Streams* – SPTS)
    → Packets may be simply removed, and the result is still compliant
  - Transport Streams with multiple time bases must be CBR (*Multiple Program Transport Streams* – MPTS)
    → Packets may be replaced but not removed

Selection at the Receiver

- The receiver has the following selection options:
  - Select only the programs a list
    (e.g., send me only programs 1, 3 and 7)
  - Select all programs except the ones in a list
    (e.g., send me everything except programs 2, 3 and 8)
  - Select additional PIDs to send – lists and/or ranges
    (e.g., send me also PID 0x11 – SDT for service names in DVB)
  - Block selected PIDs – lists and/or ranges
    (e.g., do not send PID 0x101 – maybe an unneeded audio PID)
  - In a RIST Tunnel, there may be multiple transport streams – receiver must be able to make independent selections per stream
- All of these are available simultaneously with fixed priority rules

Selection at the Sender

- Operationally, the sender will end up with a list of PIDs that should not be transmitted to the receiver (i.e., removed from the Transport Stream).
- The basic mechanism to achieve this while maintaining timing compliance is:
  - Replace all PIDs to be removed with NULL packets
  - Use NULL Packet Deletion (NPD) from TR-06-2 to reclaim the bandwidth, while preserving NULL packet location
  - Receiver re-inserts NULL packets, possibly re-creating a CBR stream
- For streams with a single time base, the sender may simply remove the unneeded packets (allowed by ISO/IEC 13818-1).

Selection Priority Rules

- The sender always includes the following PIDs, regardless of selection by the receiver:
  - PIDs 0 (PAT) and 1 (CAT)
  - All the PMT PIDs listed in the PAT
  - All the EMM PIDs listed in the CAT
- At the program and PID levels, if a program or PID is listed both in the selection list and in the blocked list, it **is** included in the transmission (selection takes priority)
- If a PID is present in the PMT of a selected program, but explicitly blocked in a PID list, it **is not** included in the transmission (the more granular choice takes priority)

Motivation for the Rules

- Having the PAT and all the PMTs available allows the receiver to always have a complete picture of the contents of the Transport Stream, speeding up selection changes.
- In case of scrambled content, EMMs are crucial to entitle the receiver and must never be missed.
- Giving priority to “select” over “block” ensures that content is available in case of mistakes (most conservative choice).
- Allowing the receiver to select a program and block a PID allows for dropping of unneeded elements.
  - Example: program with multiple languages going into an area where only one is needed.

Protocol Implementation – Main Profile

- RIST Main Profile (TR-06-2) includes per tunnel **Keep-Alive** message that is separate from the traffic, sent periodically.
- The Keep-Alive message has an optional JSON payload.
- The content selection is an extension of the JSON message.
  - Backward-compatible: if the sender does not support content selection, it will simply ignore the request.
- Support for the JSON message is required for content selection.

Protocol Rules

- Receiver must include the content selection JSON fragment in the Keep-Alive message until it detects that the sender has complied with the selection.
- The receiver can stop sending the selection once it has detected compliance but must re-send at least once every 30 seconds.
- If the content selection JSON fragment is not present, the sender interprets it as “keep doing what you are doing now”.
- In case of disconnection, the receiver must go back to sending the selection on every Keep-Alive.

JSON Syntax

```
"contentSelection": [
  {
    "UDPPort": 5000,
    "DestinationIP": "239.1.1.1",
    "SourceIP": "192.168.1.1",
    "requestedPrograms": [1, 2, 3],
    "requestedPIDs": ["0x110-0x11F", "0x200"],
    "blockedPrograms": [4, 5, 6],
    "blockedPIDs": ["0x300-0x30F", "0x400", "0x500"]
  },
  {
    "UDPPort": 6000,
    "DestinationIP": "239.1.1.2",
    "SourceIP": "192.168.1.2",
    "requestedPrograms": [11, 12, 13],
    "requestedPIDs": ["0x210-0x21F", "0x300"],
    "blockedPrograms": [14, 15, 16],
    "blockedPIDs": ["0x400-0x40F", "0x500", "0x600"]
  }
]
```

Destination UDP port in the tunnel

Optional destination IP address*

Optional source IP address*

List of selected programs, by program number

List of selected PIDs, with range support

Blocked Programs

Blocked PIDS

*Not available for Reduced Overhead flows

Another flow in the same tunnel

COBALT.

Advanced Profile Support

- RIST Advanced Profile includes a control channel with an encapsulation already defined for the Main Profile Keep-Alive messages, which are mandatory.
  - Just use that for the selection.
- Stream encapsulation can use several methods:
  - Encapsulated Main Profile Packets (Type 8)
  - Direct encapsulation of Reduced Overhead packets (Type 3)
  - Direct payload (Type 5) with no wrappers and payload compression
  - Direct payload (Type 5) with RTP headers and NPD

Application Scenario 1: Audio Selection

<table>
<tr><th colspan="2">Transport Stream</th></tr>
<tr><td colspan="2">PID 0: PAT
Program 1: PMT is at 0x100</td></tr>
<tr><td colspan="2">PID 0x11: SDT
Program 1 Name is “Music Channel”</td></tr>
<tr><td rowspan="4">PID 0x100:
Program 1 PMT</td><td>PID 0x200: H.264 Video</td></tr>
<tr><td>PID 0x210: AAC audio, ENG</td></tr>
<tr><td>PID 0x211: Dolby audio, ENG</td></tr>
<tr><td>PID 0x21F: SCTE-35 Cue</td></tr>
</table>

Requirement: only need the AAC audio

Selection:

```
"contentSelection": [
  {
    "UDPPort": 5000,
    "requestedPrograms": [1],
    "requestedPIDs": ["0x11"],
    "blockedPIDs": ["0x211"]
  }
```

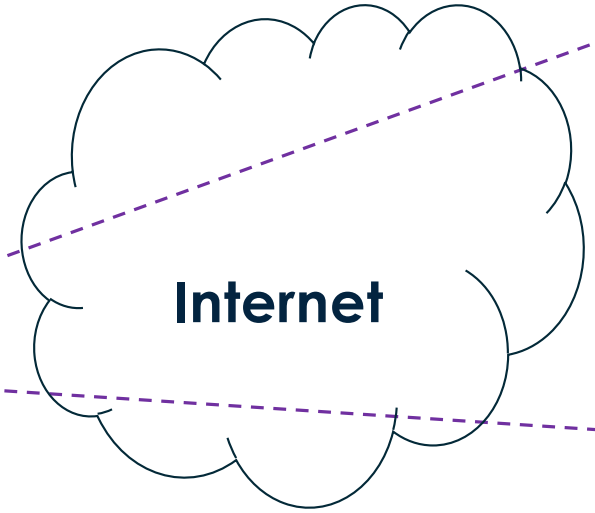
Sender Actions:

- Send PIDs **0x0**, **0x11**, **0x100**, **0x200**, **0x210**, **0x21F**
- Replace PID **0x211** with NULL packets (or remove it since this is an SPTS)

COBALT

Application Scenario 2: Network Feed

Network Feed
1: News West
2: Sports West
3: News East
4: Sports East
5: Special Events




```
"contentSelection": [
  {
    "UDPPort": 5000,
    "requestedPrograms": [1,2,5]
  }
```


```
"contentSelection": [
  {
    "UDPPort": 5000,
    "requestedPrograms": [3,4,5]
  }
```

COBALT

Application Scenario 3: Slow Start

- Receiver has limited bandwidth and is not able to receive the full transport.
- Receiver has no a-priori knowledge of the transport.
- Receiver will connect, but block everything at first (except the SDT for service names):

```
"contentSelection": [
  {
    "UDPPort": 5000,
    "requestedPIDs": ["0x11"],
    "blockedPIDs": ["0x0-0x1FFF"]
  }
]
```

- Receiver now selects a program:

```
"contentSelection": [
  {
    "UDPPort": 5000,
    "requestedPIDs": ["0x11"],
    "requestedPrograms": [1]
  }
]
```

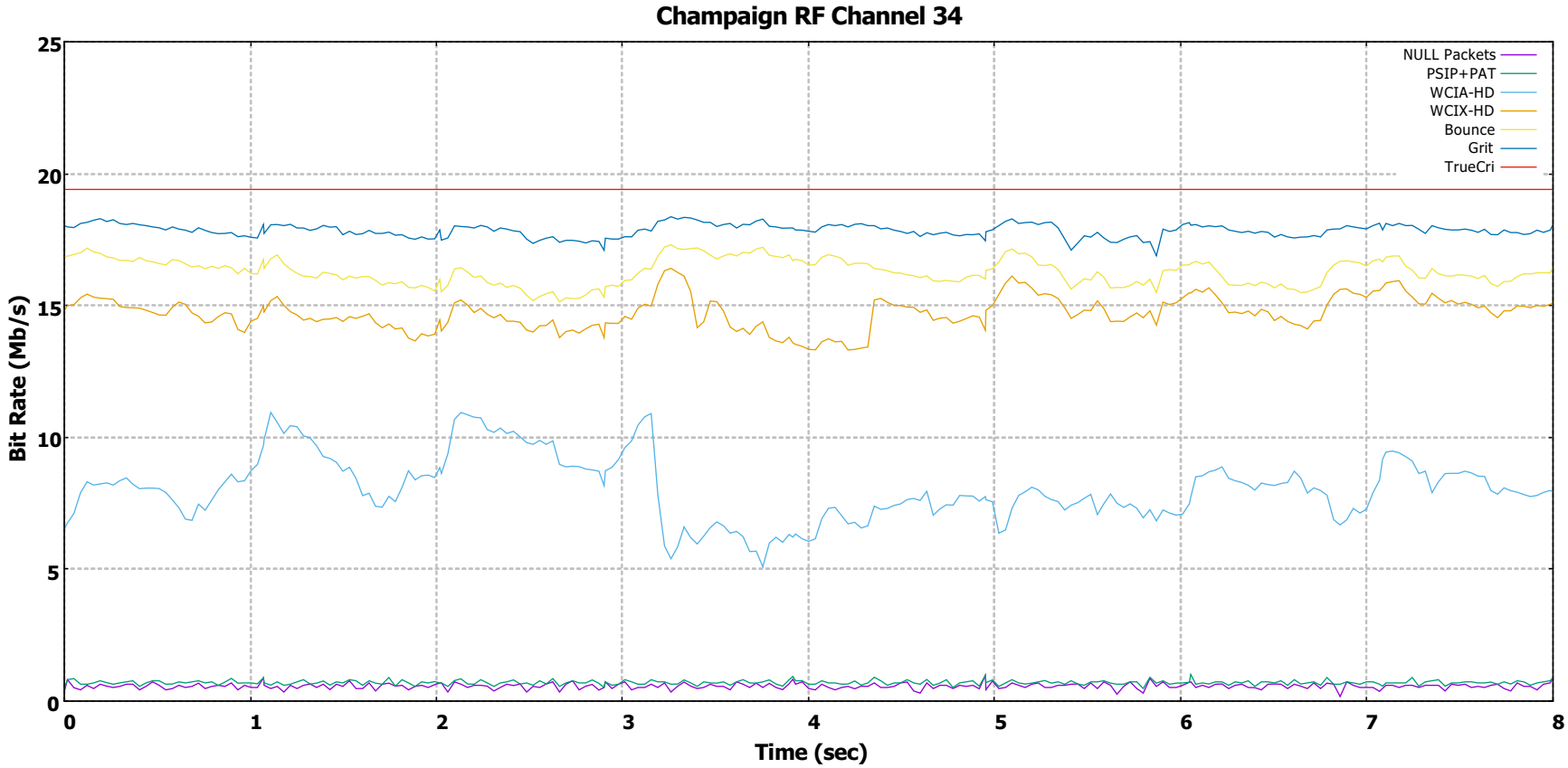
Actual Testing Data Using Off-Air Feed

- Source: ATSC-1 RF channel 34 in Champaign, IL
- Traditional MPEG-2 statmux with the following content:
  - Program 3, Channel 3.1, "**WCIA-HD**", 1080i Video + 5.1 Audio + 2.0 Audio, average rate **6.7 Mb/s**
  - Program 4, Channel 3.2, "**WCIX-HD**", 1080i Video + 5.1 Audio + 2.0 Audio, average rate **6.7 Mb/s**
  - Program 5, Channel 3.3, "**Bounce**", SD Video + 2.0 Audio, average rate **1.8 Mb/s**
  - Program 6, Channel 3.4, "**Grit**", SD Video + 2.0 Audio, average rate **1.6 Mb/s**
  - Program 7, Channel 27.2, "**TrueCri**", SD Video + 2.0 Audio, average rate **1.8 Mb/s**

	Decoder 2 Input: Transport 0x3E1				
	Program 3 (0x30)	Program 4 (0x40)	Program 5 (0x50)	Program 6 (0x60)	Program 7 (0x70)
Program Name	3.1: WCIA-HD	3.2: WCIX-HD	3.3: Bounce	3.4: Grit	27.2: TrueCri
Elements	0x31:Video/MPEG-2	0x41:Video/MPEG-2	0x51:Video/MPEG-2	0x61:Video/MPEG-2	0x71:Video/MPEG-2
	0x34:Audio/Dolby AC-3 (ENG)	0x44:Audio/Dolby AC-3 (ENG)	0x54:Audio/Dolby AC-3 (ENG)	0x64:Audio/Dolby AC-3 (ENG)	0x74:Audio/Dolby AC-3 (ENG)
	0x35:Audio/Dolby AC-3 (SPA)	0x45:Audio/Dolby AC-3 (SPA)	-	-	-

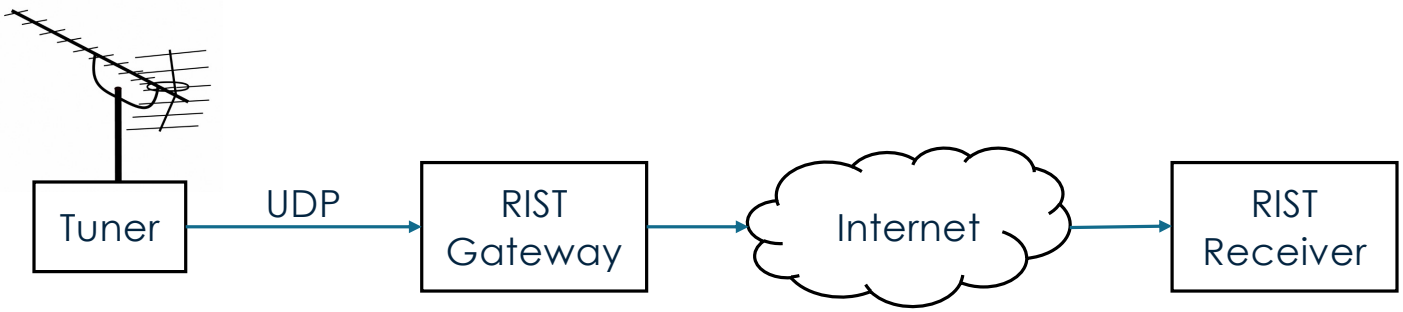
COBALT.

Statmux View



COBALT.

Test Environment



Selection:

- Send programs 3, 4, 5, 6, 7
- Send programs 3, 4, 5, 6
- Send programs 3, 4, 5
- Send programs 3, 4
- Send program 3
- Send programs 3, 4
- Send programs 3, 4, 5
- Send programs 3, 4, 5, 6
- Send programs 3, 4, 5, 6, 7

Include the VCT in all selections

One minute per selection

RIST Main Profile Reduced Overhead

NPD for bandwidth savings

COBALT.

VID25 TRANS

PID View

PID	Bit Rate
0x0	18644
0x30	5220
0x31	4570905
0x34	399739
0x35	204344
0x40	5220
0x41	9178354
0x44	398248
0x45	204344
0x50	5220
0x51	869583
0x54	203598
0x60	5220
0x61	1002332
0x64	205090
0x70	5220
0x71	1225321
0x74	204344
0x1FFB	34306
0x1FFF	643610

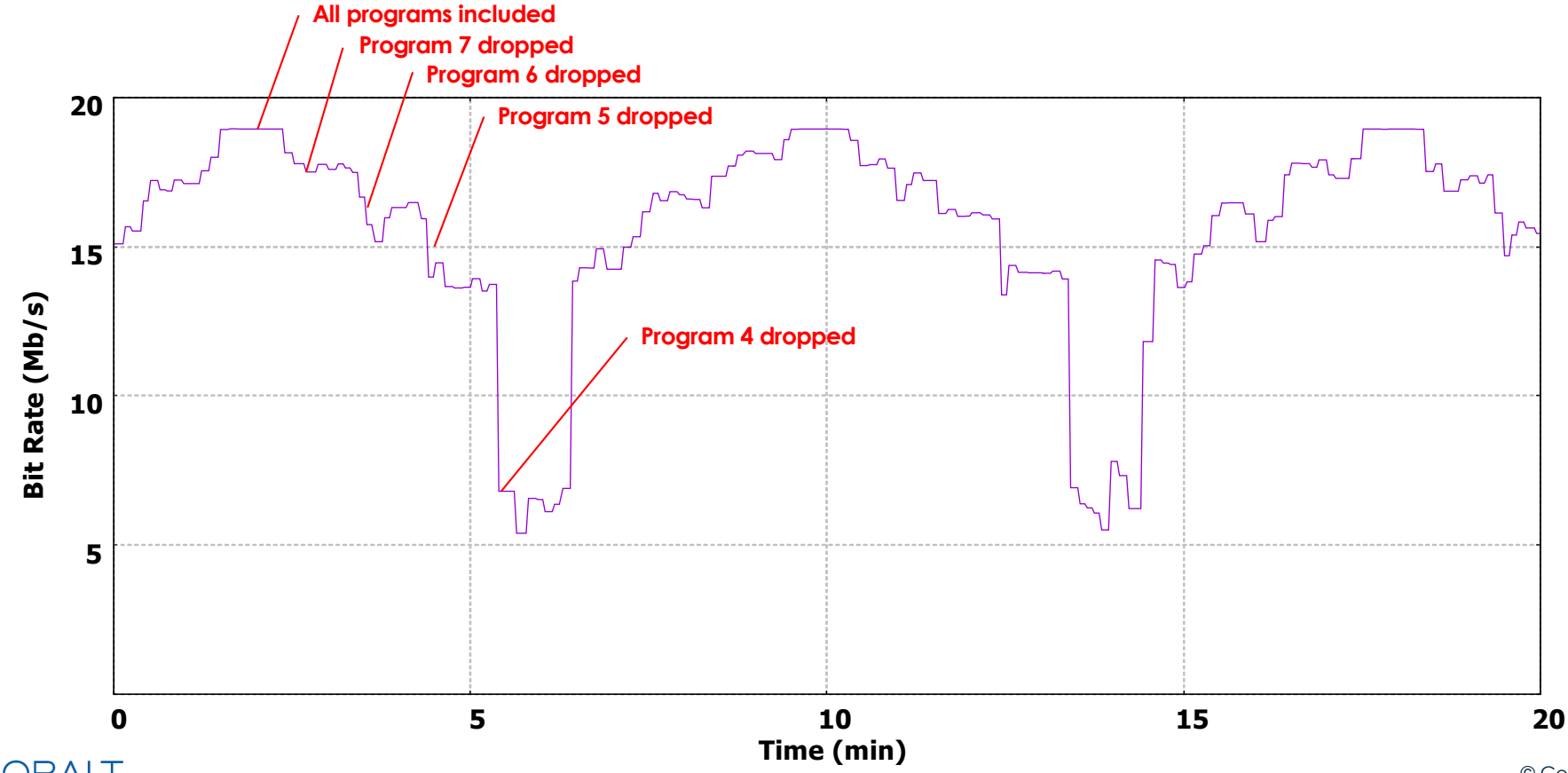
All Programs

PID	Bit Rate
0x0	18623
0x30	4469
0x31	5535620
0x34	399285
0x35	203367
0x40	4469
0x41	0
0x44	0
0x45	0
0x50	5214
0x51	0
0x54	0
0x60	5214
0x61	0
0x64	0
0x70	5214
0x71	0
0x74	0
0x1FFB	34267
0x1FFF	13171961

Only Program 3

COBALT.

Measured Transport Bit Rate

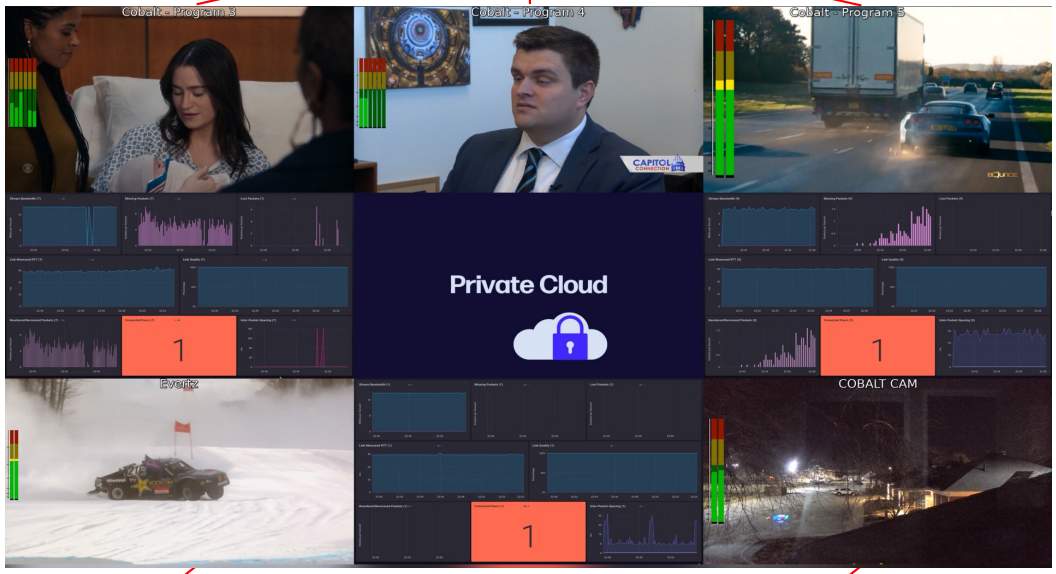


COBALT.

VID25 TRANS

VidTrans Demo

Off-Air Programs 3, 4, and 5
Transmitted from Champaign to the Cloud



Evertz **Cobalt**

Receivers and Cloud Multiviewer provided by SipRadius

COBALT.

VID25 TRANS

Q&A

- Questions?
- Thanks!

Contact:

ciro.noronha@cobaltdigital.com

COBALT

Thank you

vsf.tv