NMOS **A**dvanced **S**treaming **A**rchitecture Enhanced Capabilities and more …

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matrox video

v0.2

Public GitHub Repository

- https://github.com/alabou/NMOS-MatroxOnly
  - README.md
  - ReceiverCapabilities.md
  - SenderCapabilities.md
  - NMOS With IS-11.md

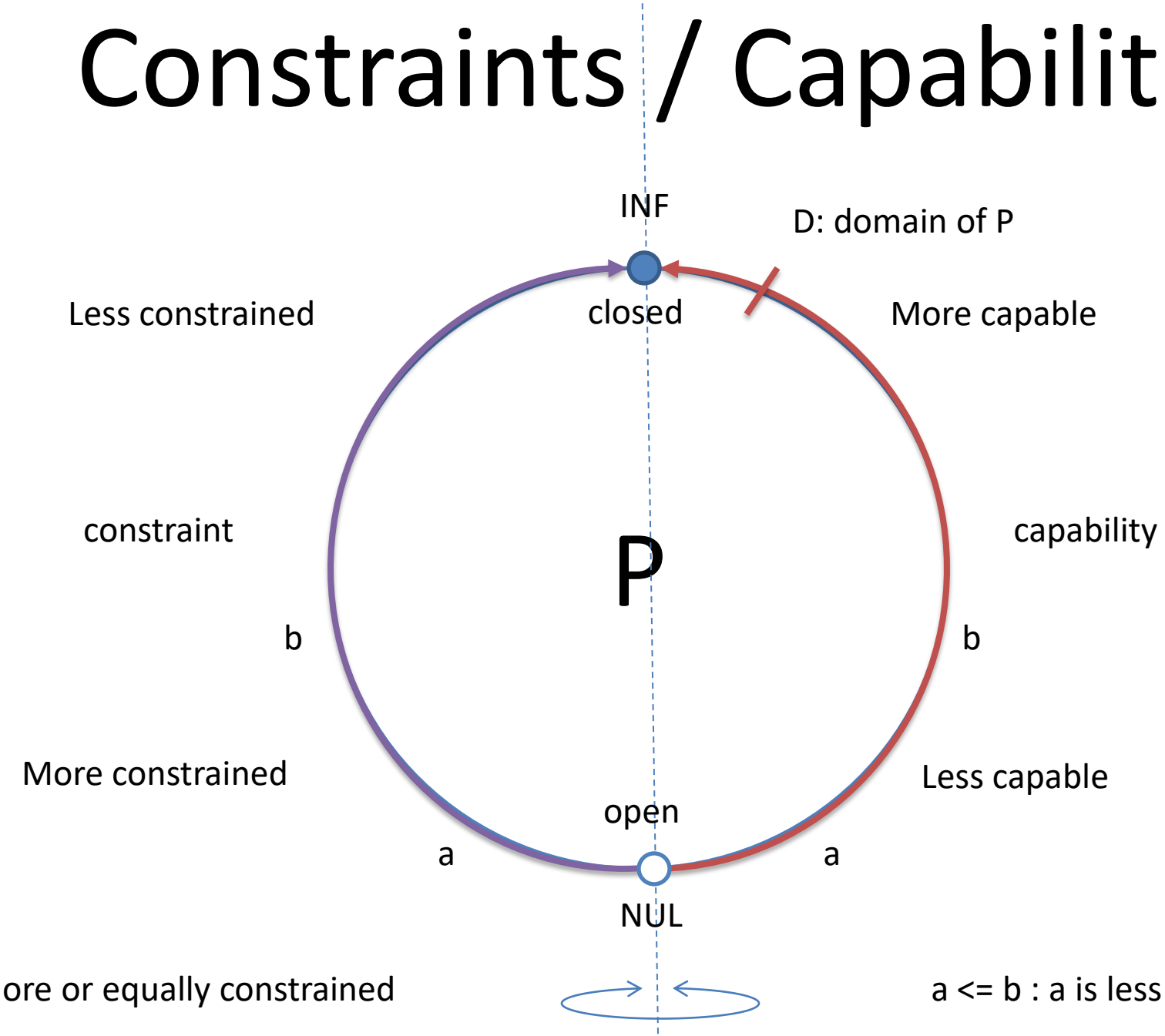
Capabilities

- Describe what is allowed, available or possible.
- Describe the possible values of a parameter.
  - Capability Space (CapS) of parameter P
- A capability essentially outlines the permissible values or operational space of a parameter, representing what is possible or supported.

Constraints

- Constrain what is allowed, available or possible.
- Constrain the possible values of a parameter.
  - Constraint Space (ConS) of parameter P
- A constraint essentially restricts the permissible values or operational space of a parameter, representing what is possible or supported. Its key purpose is to **reduce or limit the flexibility** provided by capabilities.

Constraints / Capabilities

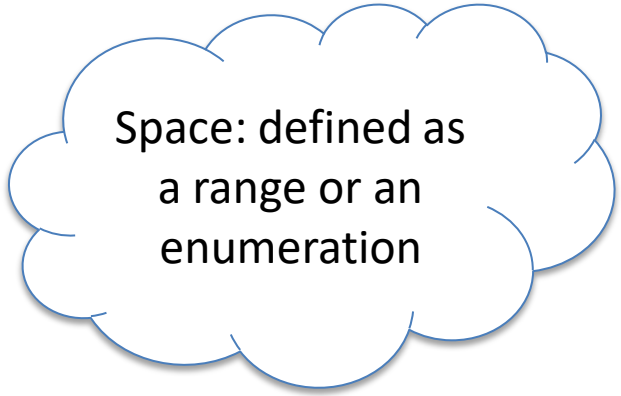


a <= b : a is more or equally constrained

a <= b : a is less or equally capable

Parameter P

- Capability / Constraint Space of P (CapS / ConS)
  - Types: Bool, Integer, Float, Rational, String or Untyped
  - Range: Finite or Infinite



- Domain of P (D)
  - Real and Finite
  - Associated Capability/Constraint Space
    - May extend beyond the domain of P, spanning an infinite range (INF).
- Degrees of freedom of a set of P (DoF)
  - from 1 to infinite

Constraint/Capability Duality

- A range describes either a Capability or a Constraint
  - Represents the Capability / Constraint Space of Parameter P.
- A range identity, Caps or Cons, is fixed at processing time
  - Infinite Range (INF):
    - As a **Capability**: Indicates the parameter supports any value.
    - As a **Constraint**: Implies no restriction is imposed on the parameter.

Parameter Space Pyramid (2D)

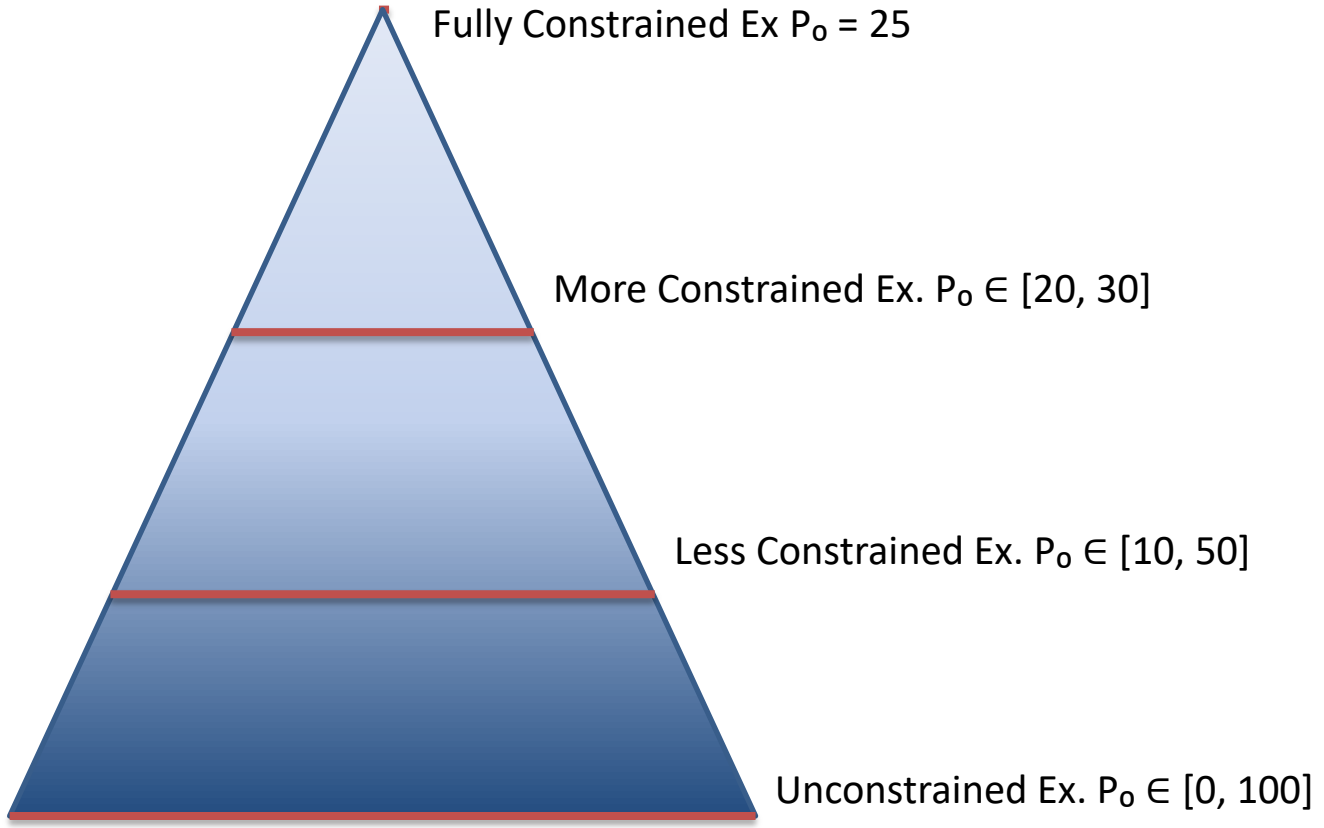
Space of a single possible value

smaller space

constricting

larger space

Space of many possible values



Parameter P_0

DoF equals 1

Parameter Space Pyramid (3D)

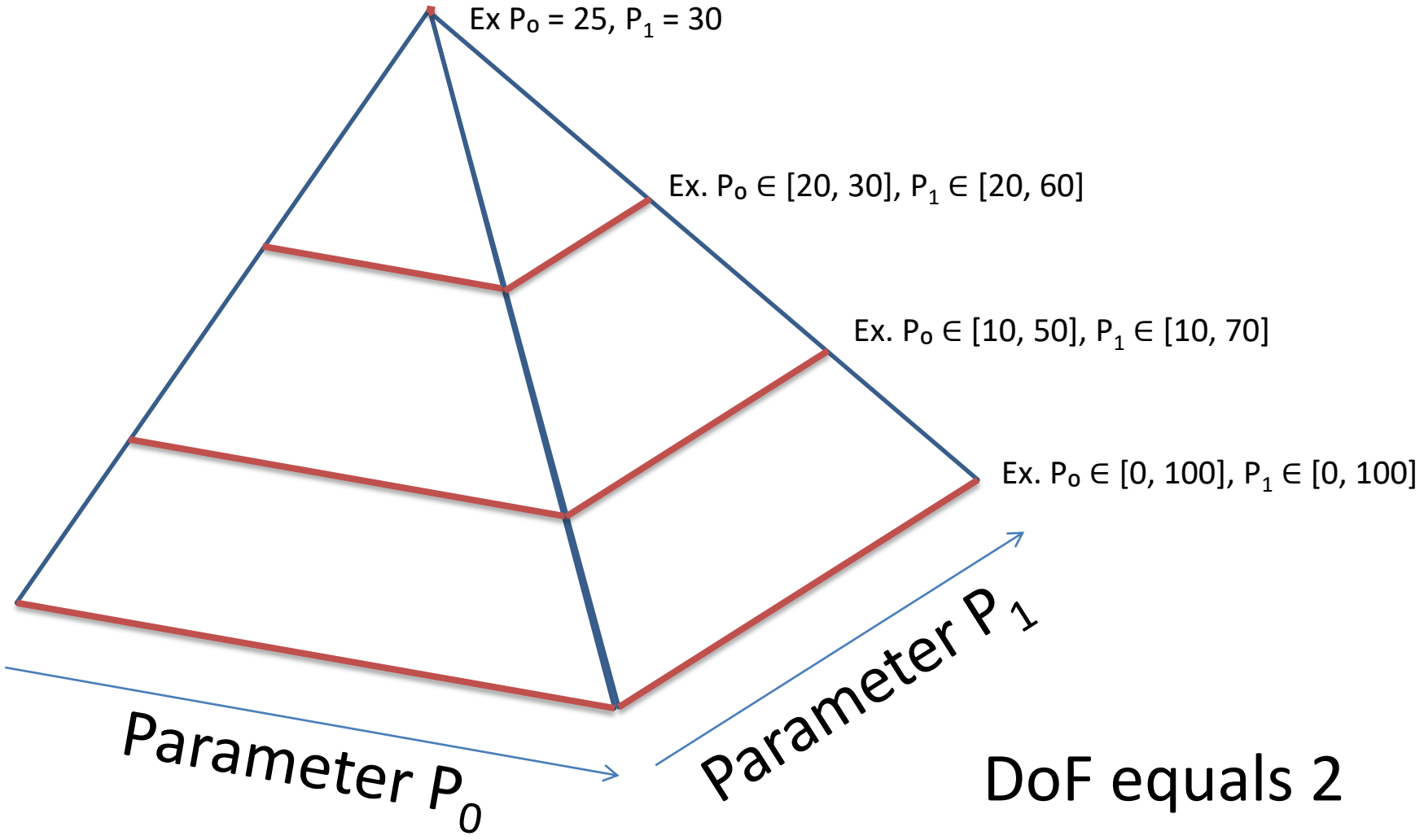
Space of a single possible value

smaller space

constricting

larger space

Space of many possible values

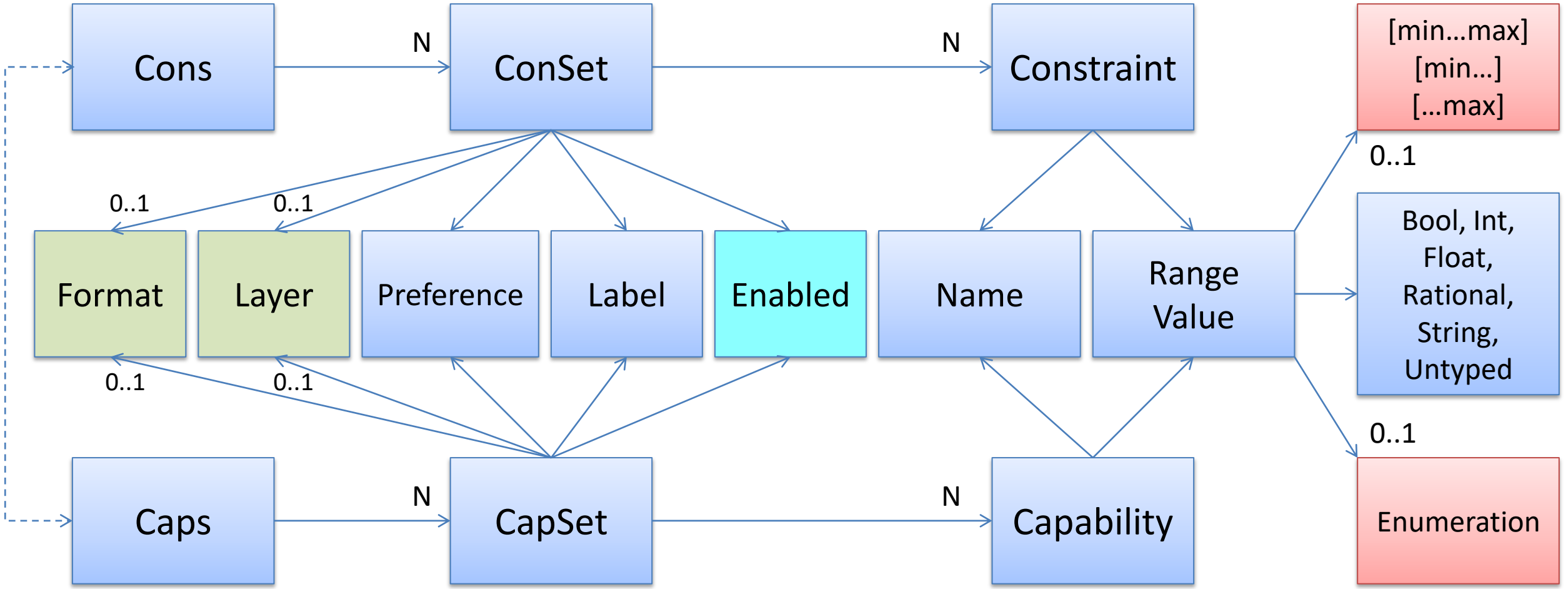


DoF equals 2

Parameter Space Pyramid (nD)

- HyperPyramid of n dimensions
  - Representation for more than 2 parameters

Enhanced Capabilities



Infinite Range

- If there is no range and no enumeration

  INF => Infinite range

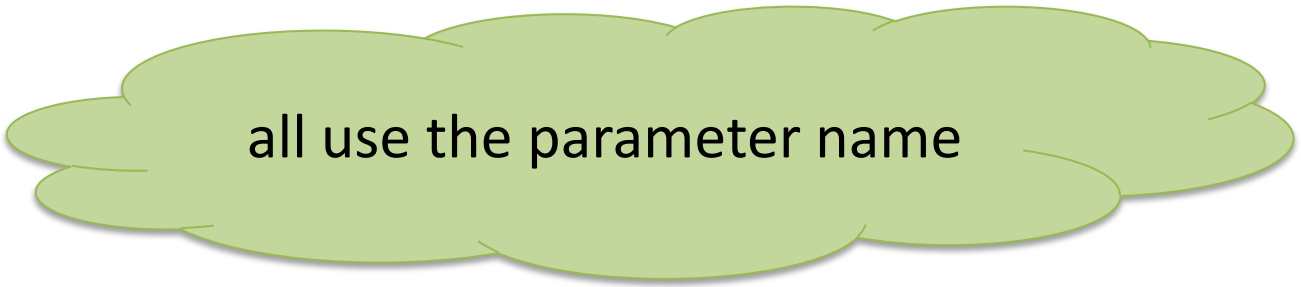
BCP-004-01 / 02 do not support the concept of a NUL empty range

An empty enumeration or range is not allowed => NUL not allowed

Flow/Stream Parameters

- Flow parameters => NMOS Flow/Source attributes
- Stream parameters => SDP transport file parameters

(Constraints ↔ Capabilities) → Parameters



Base Concepts

- Capability / Constraint
  - name: str
  - value: RangeValue

The name is the associated parameter name

[min…max], [min…], […max]
enumeration
INF

Examples:

- “media_type” allows [“video/raw”, “video/jxsv”, “video/h264”, “video/h265”]
- “media_type” allows INF

BCP-004-01 / 02
refer to Constraint
Set even for
capabilities.

Base Concepts

- CapSet / ConSet
  - caps: Dict[str, Capability / Constraint] = dict()
  - enabled: bool = False
  - preference: int = 0
  - label: str = “”
  - format: Optional[str] = None
  - layer: Optional[int] = None
  - layer_enabled: Optional[bool] = None
  - layer_compatibility_groups: Optional[List[int]] = None

Parameter Space

sub-Flows
sub-Streams

Base Concepts

- Caps
  - capsets: List[CapSet] = list()
- Cons
  - consets: List[ConSet] = list()

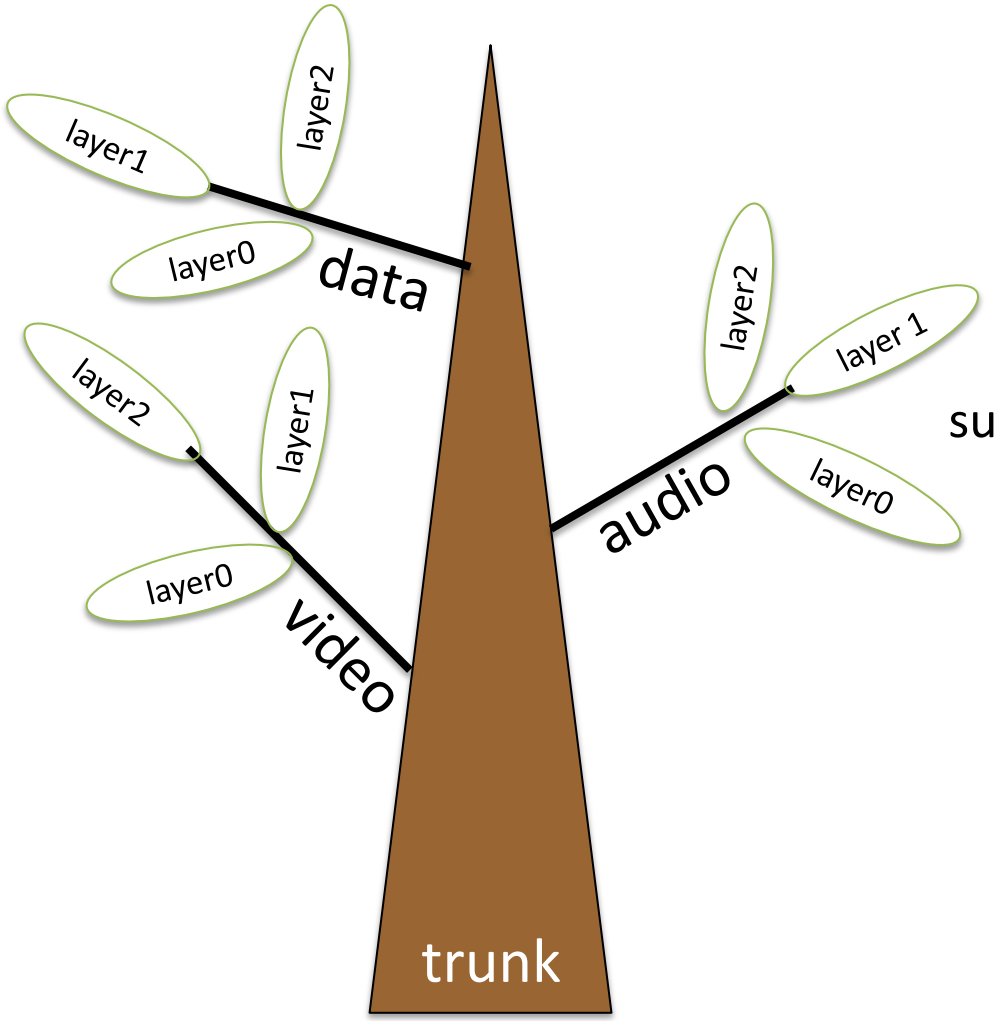
Caps ←→ Cons conversion

Change the interpretation to be given to unspecified parameters. If “unspecified” is to mean “may take any value” then Caps. If “unspecified” is to mean “don’t care” then Cons.

Alternate Parameter Spaces
Multi-Part Parameter Spaces

- Sender and Receiver Capabilities are Caps **(can do)**
  - Sender Active Constraints are Cons **(must do)**

Enhanced Capabilities => Multiple Parts



sub-Flow/sub-Stream CapSets/ConSets

Trunk CapSets/ConSets

Flows / Streams => trunk

- Flows/Streams CapSets/ConSets
  - enabled is True
  - No layer_enabled, format, layer attributes
  - Optional layer_compatibility_groups attribute (mux)

} Identifies a CapSet/ConSet as being a sub-Flow/sub-Stream.

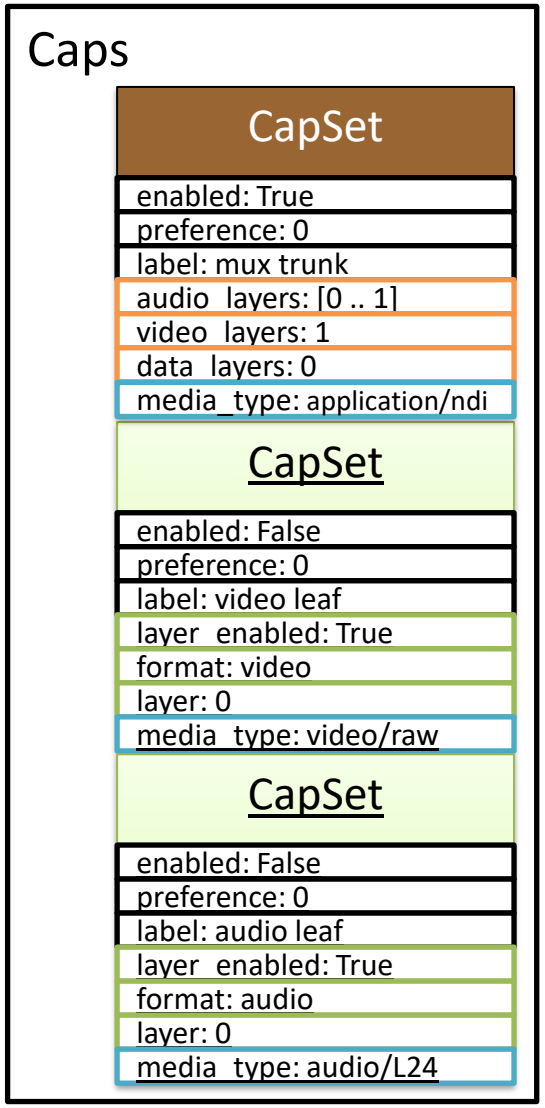
sub-Flows / sub-Streams => leaves

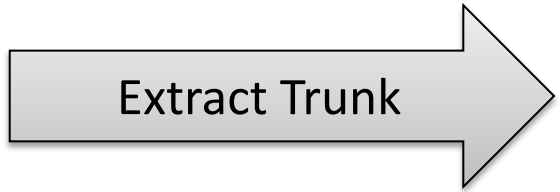
- sub-Flows/sub-Streams CapSets/ConSets
  - enabled is False => use layer_enabled instead
  - layer_enabled, format, layer attributes (required)
  - layer_compatibility_groups attribute (optional)

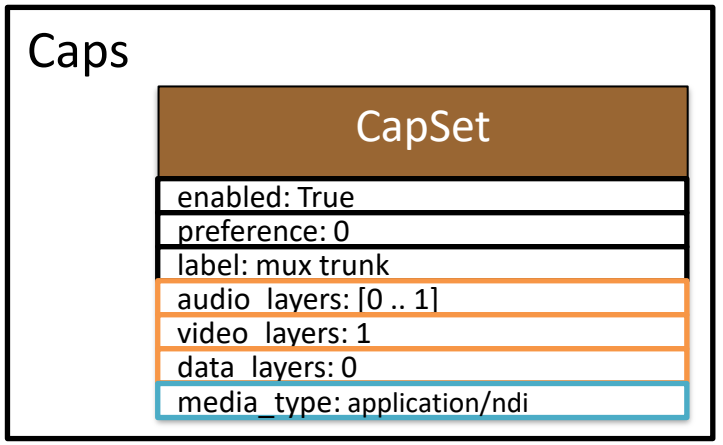
Identifies a CapSet/ConSet as being a sub-Flow/sub-Stream.

A Controller not supporting enhanced Capabilities will simply ignore this CapSet/ConSet as it is disabled.

Caps Filtering

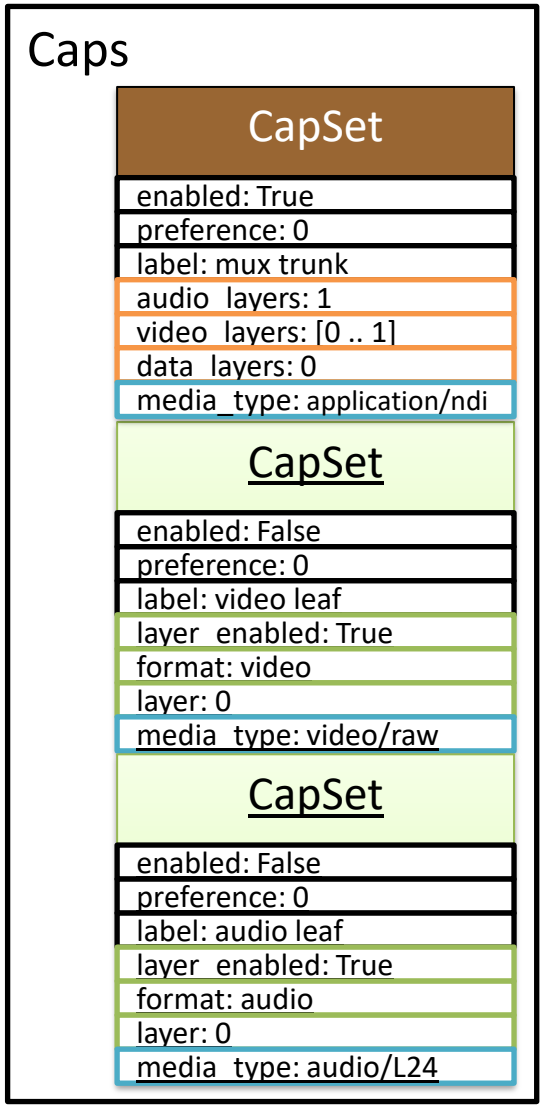


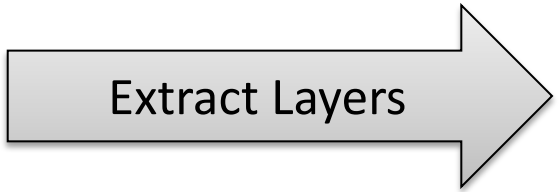


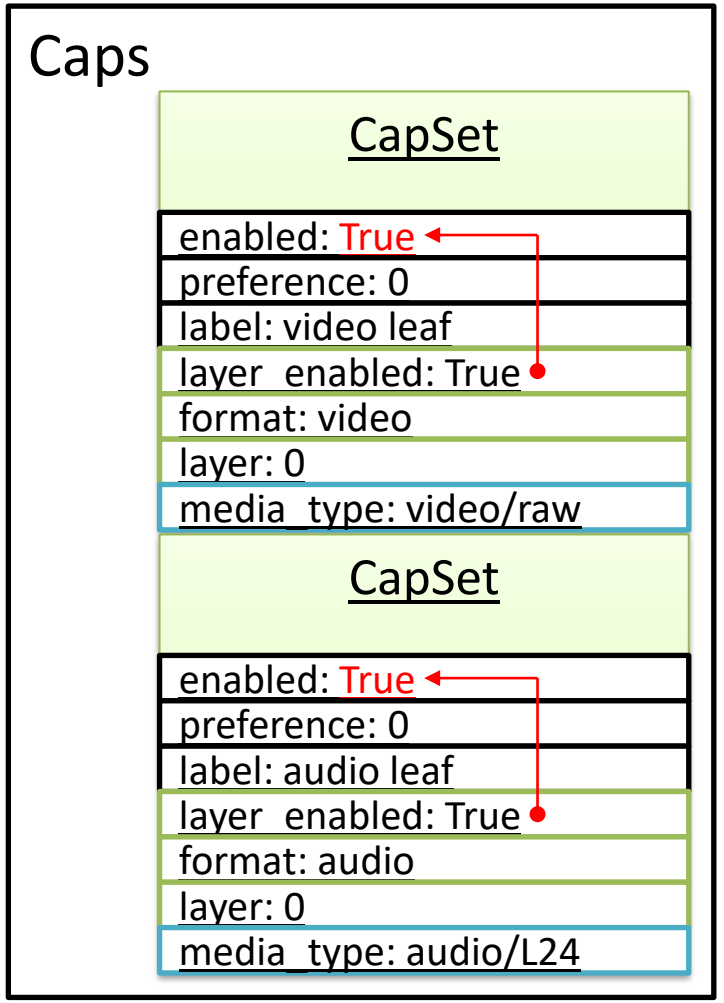


Leaves CapSet being disabled are not considered by Controller not supporting enhanced capabilities. Leaves media_type is also not in the media_types array of a Receiver.

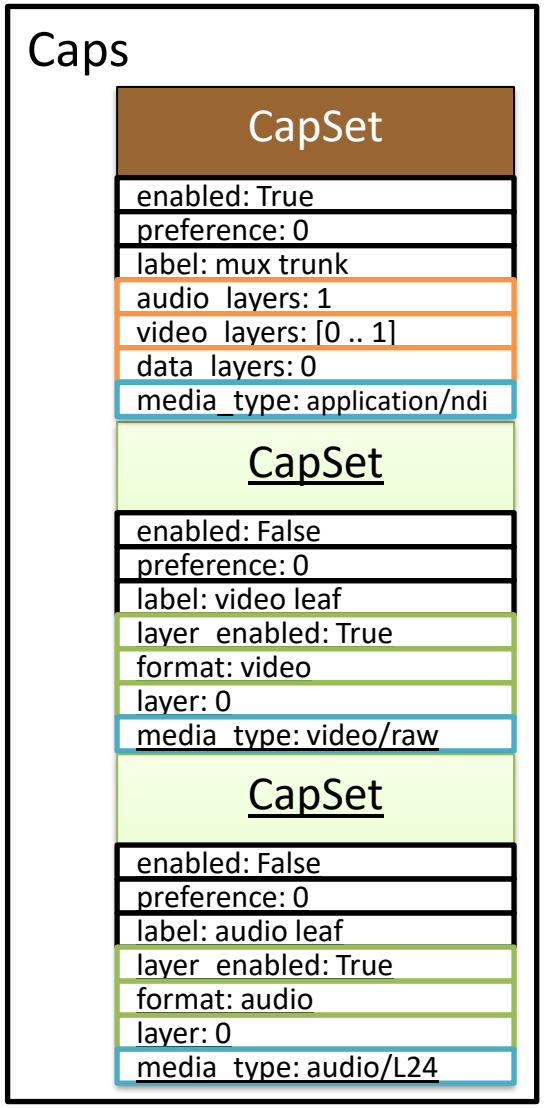
Caps Filtering

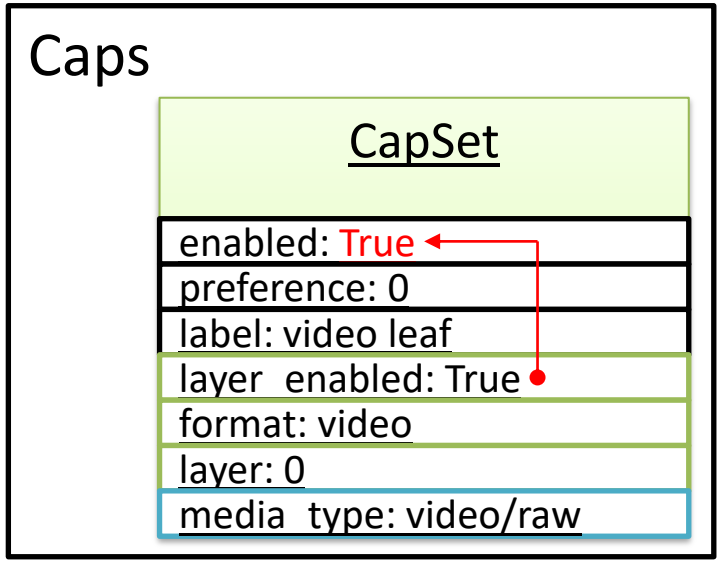






Caps Filtering





CapSet/ConSet preference

- preference of value 100 **should be** special
  - ^ tip of the parameter space pyramid
    - Represent **native** capabilities
      - One possible value per parameter (for 99% of the parameters)
    - Represent **preferred** constraints
      - First to be considered

There may be exceptional cases where some parameters of a native set are not fixed

Stream Compatibility

- Controller
  - Without IS-11
    - Current state versus Receiver(s) Capabilities
      => Fail connection if Sender not compliant
  - With IS-11
    - Sender Capabilities versus Receiver(s) Capabilities
      ⇒ Generate active constraints to make the Sender compliant
      ⇒ Fully CONFIGURE the Sender

Stream Compatibility

- Controller
  - With IS-11 (Hybrid)
    - Sender Capabilities versus Receiver(s) Capabilities

      ⇒ Generate active constraints to make the Sender compliant

      ⇒ Partially CONFIGURE the Sender
    - Current state versus Receiver(s) Capabilities

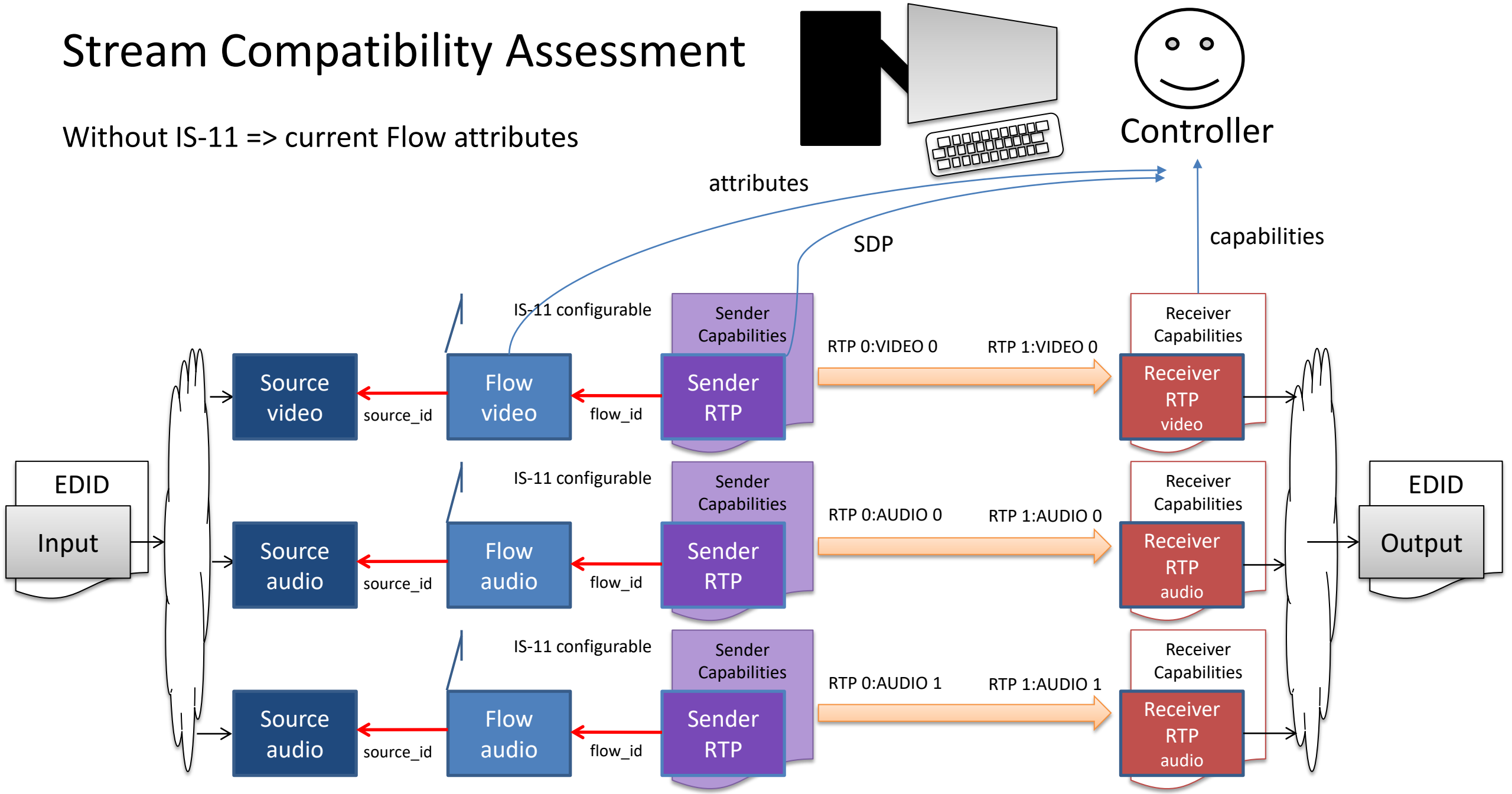
      => For parameters that cannot be constrained

Stream Compatibility

- Controller
  - Ensures that the actual Sender's Flow/Stream parameters are within the parameter space of the subscribed Receivers.
    - For each layer: ensures that the actual Sender's sub-Flow/sub-Stream parameters are within the parameter space of the subscribed Receivers.
  - Ensures that the Sender's constrained Flow/Stream parameters are within the parameter space of the subscribed Receivers.
    - For each layer: ensures that the Sender's constrained sub-Flow/sub-Stream parameters are within the parameter space of the subscribed Receivers.

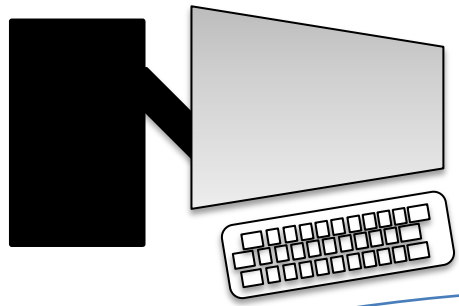
Stream Compatibility Assessment

Without IS-11 => current Flow attributes



Stream Compatibility Assessment

With IS-11 => active constraints



Controller

Parameters not supported as active constraints may require an assessment using the actual attributes

capabilities

supported constraints

capabilities

IS-11 configurable

Sender Capabilities

Sender RTP

RTP 0:VIDEO 0

RTP 1:VIDEO 0

Receiver Capabilities

Receiver RTP video

Source video

source_id

Flow video

flow_id

EDID

Input

IS-11 configurable

Sender Capabilities

Sender RTP

RTP 0:AUDIO 0

RTP 1:AUDIO 0

Receiver Capabilities

Receiver RTP audio

Source audio

source_id

Flow audio

flow_id

EDID

Output

IS-11 configurable

Sender Capabilities

Sender RTP

RTP 0:AUDIO 1

RTP 1:AUDIO 1

Receiver Capabilities

Receiver RTP audio

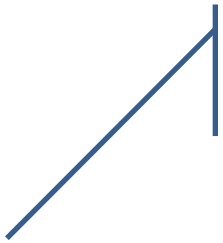
Source audio

source_id

Flow audio

flow_id

Video Capabilities



video/raw, video/jxsv, video/H264, video/H265

FORMAT (base)

- media_type (sdp) (flow)
- grain_rate (sdp) (flow)
- frame_width (sdp) (flow)
- frame_height (sdp) (flow)
- interlace_mode (sdp) (flow)
- colorspace (sdp) (flow)
- transfer_characteristic (sdp) (flow)
- color_sampling (sdp) (flow)
- component_depth (sdp) (flow)

TRANSPORT

- st2110_21_sender_type (sdp) (sender)
- clock_ref_type (sdp) (source)
- synchronous_media (sdp) (source)
- info_block (sdp) (sender)

FORMAT (coded)

- bit_rate (flow)
- constant_bit_rate (flow)
- profile (sdp) (flow)
- level (sdp) (flow)
- sublevel (sdp) (flow)

TRANSPORT

- bit_rate (sdp) (sender)
- packet_transmission_mode (sdp) (sender)
- parameter_sets_flow_mode (sender)
- parameter_sets_transport_mode (sdp) (sender)
- hkep (sdp) (sender)
- privacy (sdp) (sender)

Audio Capabilities

audio/L16, audio/L20, audio/L24, audio/AM824, audio/mpeg4-generic, audio/MP4A-LATM

FORMAT (base)

- media_type (sdp) (flow)
- channel_count (sdp) (source)
- sample_rate (sdp) (flow)
- sample_depth (sdp) (flow)

TRANSPORT

- packet_time (sdp) (sender)
- max_packet_time (sdp)
- st2110_21_sender_type (sdp) (sender)
- channel_order (sdp)
- clock_ref_type (sdp) (source)
- synchronous_media (sdp) (source)
- info_block (sdp) (sender)

FORMAT (coded)

- bit_rate (flow)
- constant_bit_rate (flow)
- profile (sdp) (flow)
- level (sdp) (flow)

TRANSPORT

- bit_rate (sdp) (sender)
- packet_transmission_mode (sdp) (sender)
- parameter_sets_flow_mode (sender)
- parameter_sets_transport_mode (sdp) (sender)
- hkep (sdp) (sender)
- privacy (sdp) (sender)

Data Capabilities

video/smpte291, application/usb

FORMAT (base)

- media_type (sdp) (flow)
- event_type (flow)

TRANSPORT

- st2110_21_sender_type (sdp) (sender)
- clock_ref_type (sdp) (source)
- synchronous_media (sdp) (source)
- info_block (sdp) (sender)

TRANSPORT

- privacy (sdp) (sender)

Mux Capabilities

application/MP2T, application/mp2t, application/ndi, application/rtsp, application/AM824

FORMAT (mux)
- media_type (sdp) (flow)
- video_layers (flow)
- audio_layers (flow)
- data_layers (flow)

Optimized Controller check against min layers only

FORMAT (video sub-stream base)
- media_type (parent flow)
- grain_rate (parent flow)
- frame_width (parent flow)
- frame_height (parent flow)
- interlace_mode (parent flow)
- colorspace (parent flow)
- transfer_characteristic (parent flow)
- color_sampling (parent flow)
- component_depth (parent flow)

FORMAT (data sub-stream base)
- media_type (parent flow)
- event_type (parent flow)

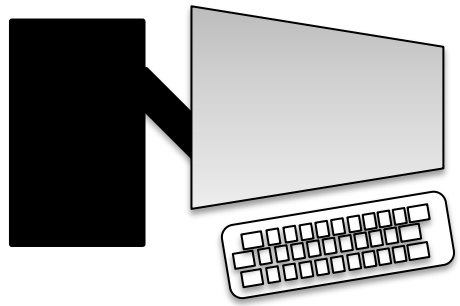
FORMAT (audio sub-stream base)
- media_type (parent flow)
- channel_count (parent source)
- sample_rate (parent flow)
- sample_depth (parent flow)

FORMAT (audio/video sub-stream coded)
- bit_rate (parent flow)
- constant_bit_rate (parent flow)
- profile (parent flow)
- level (parent flow)
- sublevel (parent flow)

TRANSPORT (mux)
- hkep (sdp) (sender)
- privacy (sdp) (sender)
- clock_ref_type (sdp) (source)
- synchronous_media (sdp) (source)

Stream Compatibility Assessment

With IS-11 => active constraints



Controller

capabilities

supported constraints

capabilities

Parameters not supported as active constraints may require an assessment using the actual attributes

IS-11 configurable

Source video

source_id

Flow video 0

parents

EDID

Input

IS-11 configurable

Source audio

source_id

Flow audio 0

parents

Flow mux

flow_id

Sender Capabilities

Sender RTP

RTP 0:MUX 0

Receiver Capabilities

Receiver RTP audio

RTP 1:MUX 0

EDID

Output

IS-11 configurable

source_id

Source audio

source_id

Flow audio 1

parents

Source mux

parents

Compatibility Groups

- For multi-part Caps/Cons
  - Group CapSets/ ConSets that are compatible
    - Ex. A multiplexed stream support
      - video: raw or HEVC
      - audio: PCM or AAC
    - If HEVC video is used, then AAC audio must also be used
      - » Put video raw and audio PCM in group 1
      - » Put video HEVC and audio AAC in group 2
  - Leaves and Trunk CapSets/ConSets compatibility groups

- This concludes our overview of NMOS Enhanced Capabilities, a key feature of Matrox NMOS Advanced Streaming Architecture.

- If you have any questions, feel free to reach out at abouchar@matrox.com.

- Thank you for attending.