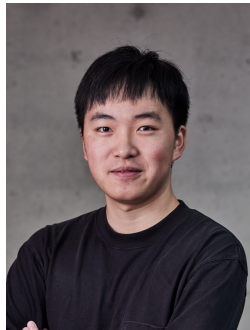


# Standardizing Multimedia QoE Telemetry from Telecommunications Networks for Open Analytics



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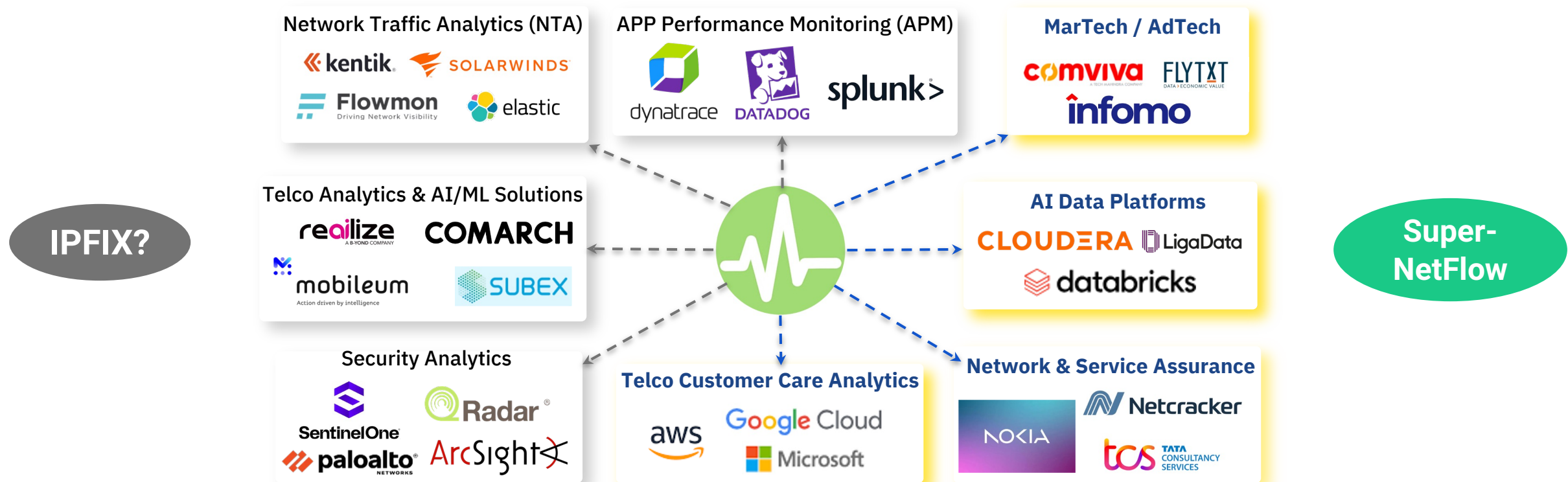
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SYDNEY

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NETWORKS

# Network operators want to benefit from AI



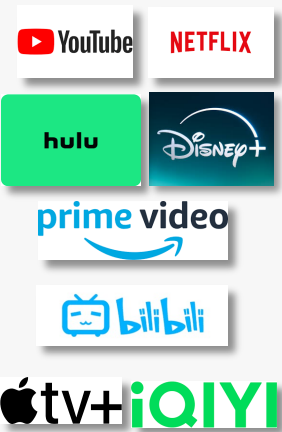
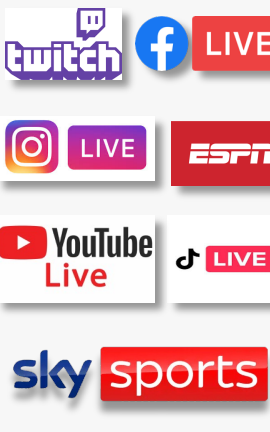

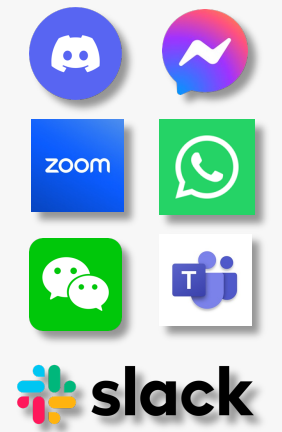
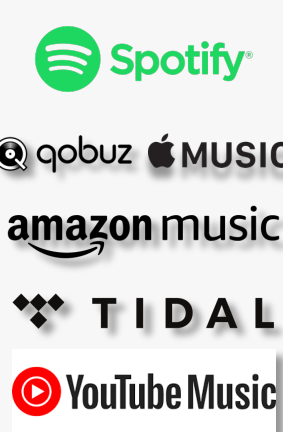


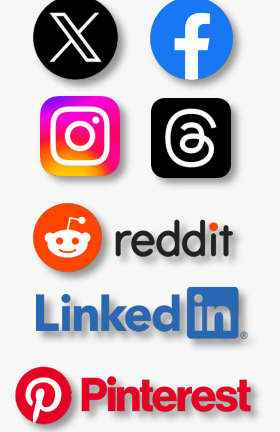
# Missing link between data generation and insight analytics

- ❑ Non-standardized, proprietary data storage and export formats

Vendor	Visibility	Granularity	Export format
Accedian [1]	App QoE	App session	Log file
Allot [2]	App QoE	Flow	Log file, database
Cambium [3]	Network QoS	Flow	Not provided
Canopus [4]	App QoE	App session	Log file, database
Sandvine [9]	App QoE	App session	Database, IPFIX
ThousandEyes [11]	Network QoS	Flow	Log file, OTel

- ❑ Existing standardized export mechanisms does not support QoE
  - CVE for cybersecurity vulnerability
  - NetFlow/IPFIX for network flow statistics
  - OpenTelemetry for application performance
  - → Standardized data schema for network measured QoE is needed!

# We consider 8 most popular app types

							
<p><b>On-demand video streaming</b></p> <ul style="list-style-type: none"><li>➤ resolution</li><li>➤ frame rate</li><li>➤ .....</li></ul>	<p><b>Live video streaming</b></p> <ul style="list-style-type: none"><li>➤ startup delay</li><li>➤ video stall</li><li>➤ .....</li></ul>	<p><b>Online gaming</b></p> <ul style="list-style-type: none"><li>➤ gameplay lag</li><li>➤ game freeze</li><li>➤ .....</li></ul>	<p><b>Voice/video calling</b></p> <ul style="list-style-type: none"><li>➤ audio dropout</li><li>➤ screen share resolution</li><li>➤ .....</li></ul>	<p><b>Music streaming</b></p> <ul style="list-style-type: none"><li>➤ audio bitrate</li><li>➤ loading delay</li><li>➤ .....</li></ul>	<p><b>Cloud gaming</b></p> <ul style="list-style-type: none"><li>➤ resolution</li><li>➤ gameplay lag</li><li>➤ .....</li></ul>	<p><b>AR/VR</b></p> <ul style="list-style-type: none"><li>➤ activity lag</li><li>➤ motion freeze</li><li>➤ .....</li></ul>	<p><b>Social networking</b></p> <ul style="list-style-type: none"><li>➤ page load time</li><li>➤ search delay</li><li>➤ .....</li></ul>

# Data schema for multimedia telemetry

## Metadata

### Identity

Session ID  
Record temporal type  
Timestamps

### Endpoint

Client address  
Server addresses  
Server names

### Context

App type  
Provider name  
Client device type  
Client software agent

## Network Stats

### Volumetric

Duration  
Byte volume  
Packet count

### QoS

Throughput  
Latency  
Jitter  
Loss

## Multimedia Application-specific QoE

### Video streaming

#### Video quality

Resolution  
Frame rate

#### Audio quality

Audio bitrate

#### Smoothness

Video stall

#### Responsiveness

Startup delay  
Time to first byte  
Chunk transfer time

#### State

Streaming type

### Online gaming

#### Responsiveness

Synchronization frequency  
Gameplay lag

#### Smoothness

Game freeze

#### State

Gameplay state

#### Audio quality

Voice chat audio bitrate

### AR/VR



...

# We have implemented the data schema

```
{
  "app_type": "video_streaming",
  "qoe_metrics": [
    {
      "category": "video_quality",
      "metrics": [
        {
          "name": "resolution",
          "indicators": [
            {
              "name": "resolution_dominant",
              "data_type": "string",
              "description": "Resolution spanning the low to high range",
              "example_values": ["SD", "HD", "FHD", "QHD"]
            },
            {
              "name": "resolution_min",
              "type": "string",
              "description": "The lowest resolution played",
              "example_values": ["SD", "HD", "FHD", "QHD"]
            }
          ]
        }
      ]
    }
  ]
}
```

QoE metrics are specific to video streaming apps

Metric category

Metric name

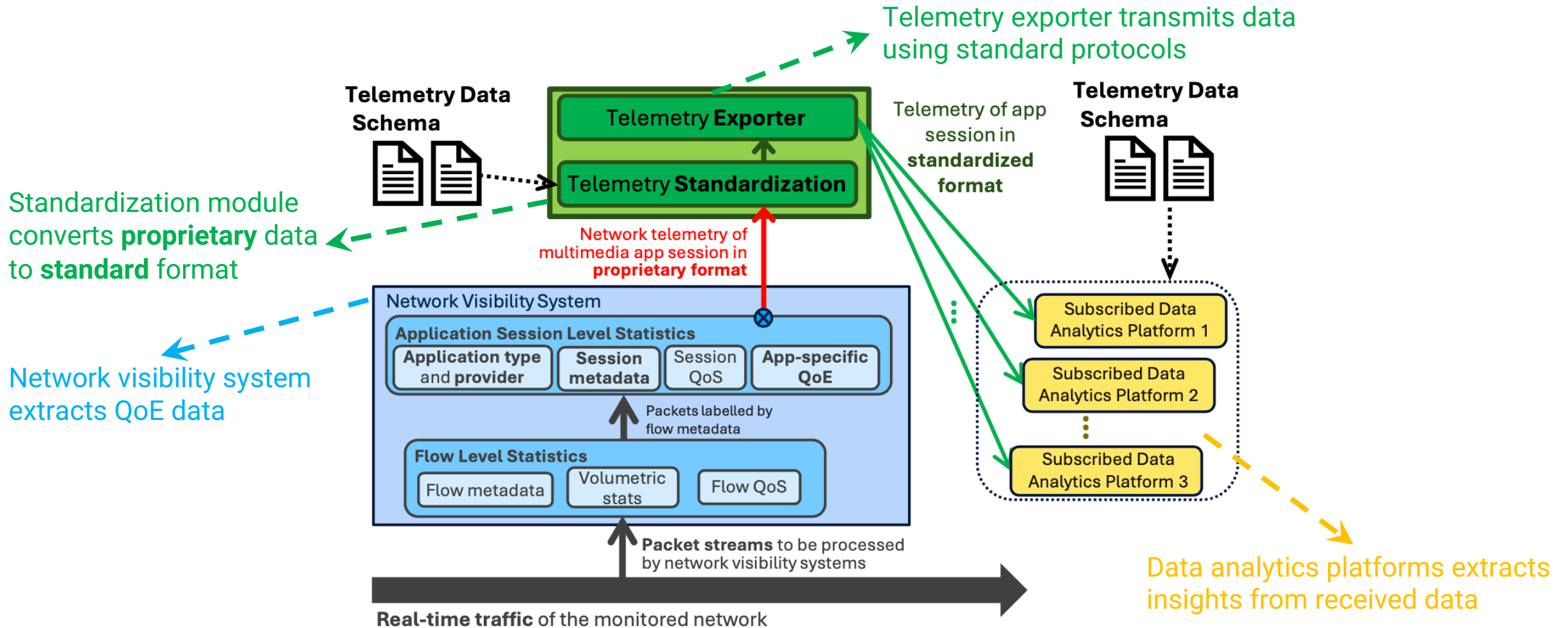
QoE metrics for video quality

Indicators of resolution metric



scan for data schema

# Unified process for QoE telemetry export



# Exporting standardized multimedia telemetry

## IPFIX

- Metric indicators → IPFIX **Information Element**
- App-specific metric selection → IPFIX **templates**

Example Information Elements  
in IPFIX messages

Name	Element ID	Data type	
sourceIPv4Addr	IANA.8	ipv4Address	Identity
applicationName	IANA.96	string	
userDeviceType	PRIV.1000	string	
.....	...	...	
flowDurationMilliseconds	IANA.161	unsigned32	QoS
throughputInboundAvgMbps	PRIV.3001	float32	
.....	...	...	
videoResolutionDominant	PRIV.4000	string	Video quality
audioBitrateAvgKbps	PRIV.5000	float32	Audio quality
videoStartupDelayMs	PRIV.6002	float32	Smoothness
videoStallDurationMs	PRIV.7001	float32	
videoStreamingType	PRIV.8000	string	Video state
.....	...	...	

## OpenTelemetry

- Static metadata → OTel **attribute**
- Timing metrics → OTel **span**
- Dynamic QoS/QoE → OTel **metric**



# Integrating with Canopus visibility engine

Template for video streaming QoE	Field length
Field 1 = video provider	variable
Field 2 = user device type	variable
Field 3 = start timestamp	8
Field 4 = end timestamp	8
Field 5 = dominant resolution	variable
Field 6 = minimum frame rate	4
Field 7 = total startup delay	4
Field 9 = total stall duration	4
.....	

```

name,id,dataType,description
resolution_dominant,55,13,Resolution of the video
resolution_min,56,13,The lowest resolution
resolution_state_uhd_sec,57,9,Resolution state UHD
resolution_state_qhd_sec,58,9,Resolution state QHD
resolution_state_fhd_sec,59,9,Resolution state FHD
resolution_state_hd_sec,60,9,Resolution state HD
resolution_state_sd_sec,61,9,Resolution state SD
resolution_state_ld_sec,62,9,Resolution state LD
resolution_prev,63,13,Video resolution previous
resolution_curr,64,13,Video resolution current
frame_rate_avg_fps,65,2,Average frame rate
frame_rate_min_fps,66,2,Minimum frame rate
audio_bitrate_avg_Kbps,67,9,Average audio bitrate
audio_bitrate_min_Kbps,68,9,Minimum audio bitrate
startup_delay_avg_sec,69,9,Average startup delay
startup_delay_max_sec,70,9,Maximum startup delay
startup_delay_sum_sec,71,9,Total startup delay
    
```

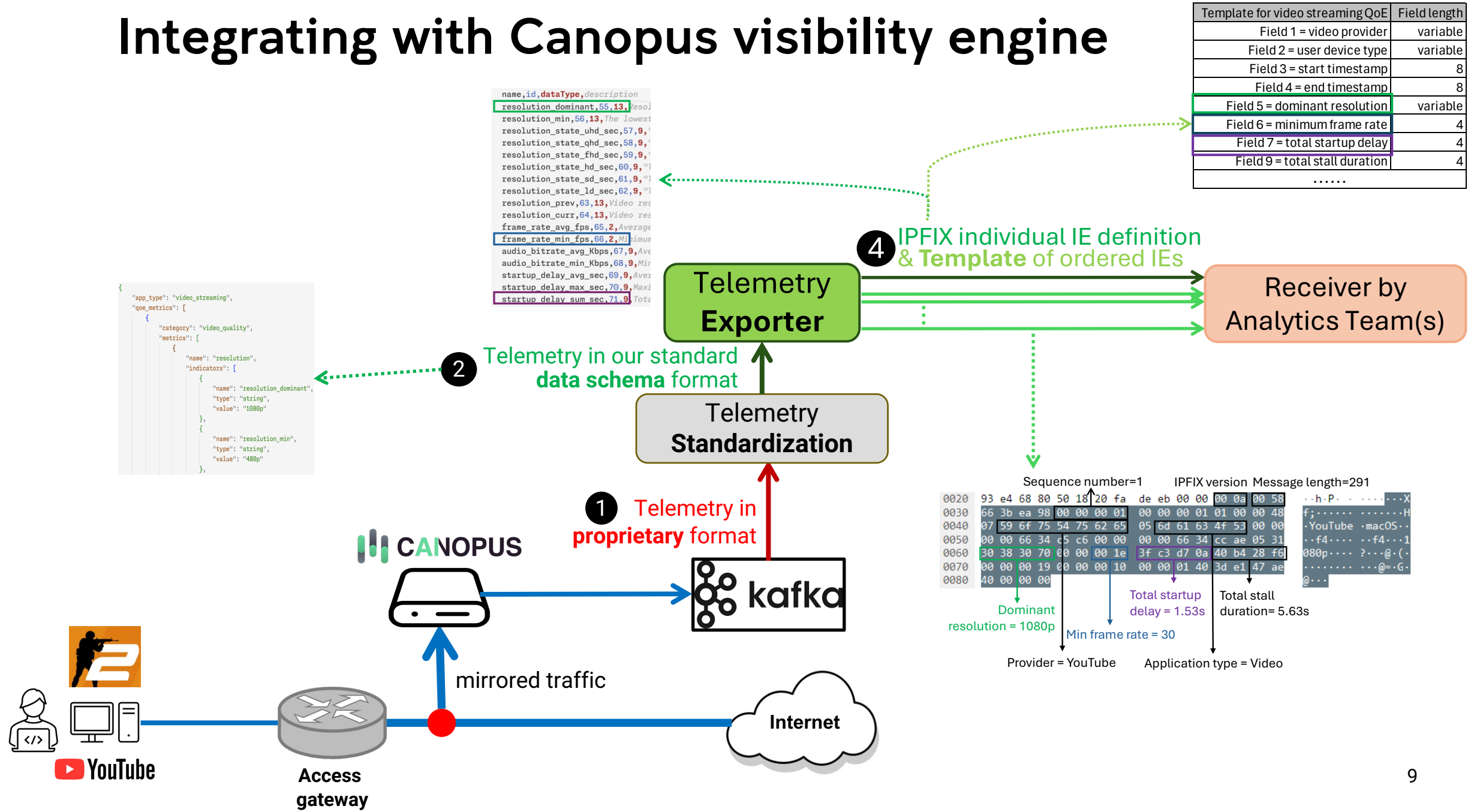
```

{
  "app_type": "video_streaming",
  "qoe_metrics": [
    {
      "category": "video_quality",
      "metrics": [
        {
          "name": "resolution",
          "indicators": [
            {
              "name": "resolution_dominant",
              "type": "string",
              "value": "1080p"
            },
            {
              "name": "resolution_min",
              "type": "string",
              "value": "480p"
            }
          ]
        }
      ]
    }
  ]
}
    
```

2 Telemetry in our standard data schema format

1 Telemetry in proprietary format

4 IPFIX individual IE definition & Template of ordered IEs



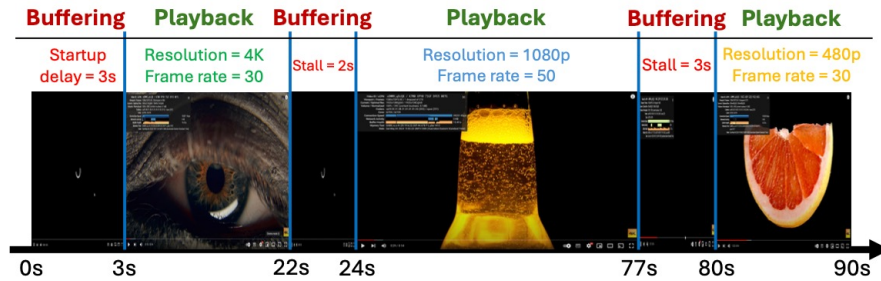
Sequence number=1 IPFIX version Message length=291

```

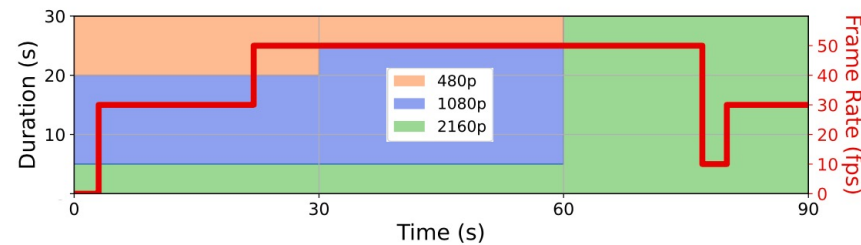
0020 93 e4 68 80 50 16 20 fa de eb 00 00 00 0a 00 58
0030 66 3b ea 98 00 00 00 01 00 00 00 01 01 00 00 48
0040 07 59 6f 75 54 75 62 65 05 6d 61 63 4f 53 00 00
0050 00 00 66 34 c5 c6 00 00 00 00 66 34 cc ae 05 31
0060 30 38 30 70 00 00 00 1e 3f c3 d7 0a 40 b4 28 f6
0070 00 00 00 19 00 00 00 10 00 00 01 40 3d e1 47 ae
0080 40 00 00 00
    
```

Dominant resolution = 1080p  
 Min frame rate = 30  
 Total startup delay = 1.53s  
 Total stall duration = 5.63s  
 Provider = YouTube    Application type = Video

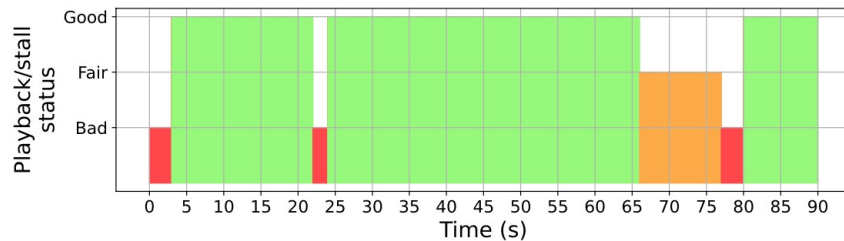
# QoE analytics for YouTube video streaming session



(a) A YouTube video session on the user device.



(b) Video resolution and frame rate.



(c) Video playback/stall status.

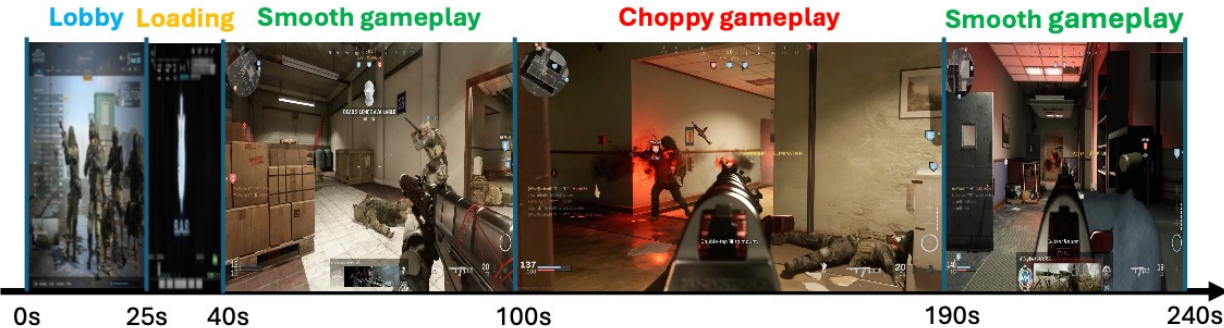
## Video resolution and frame rate

- user preferences
- experience degradation

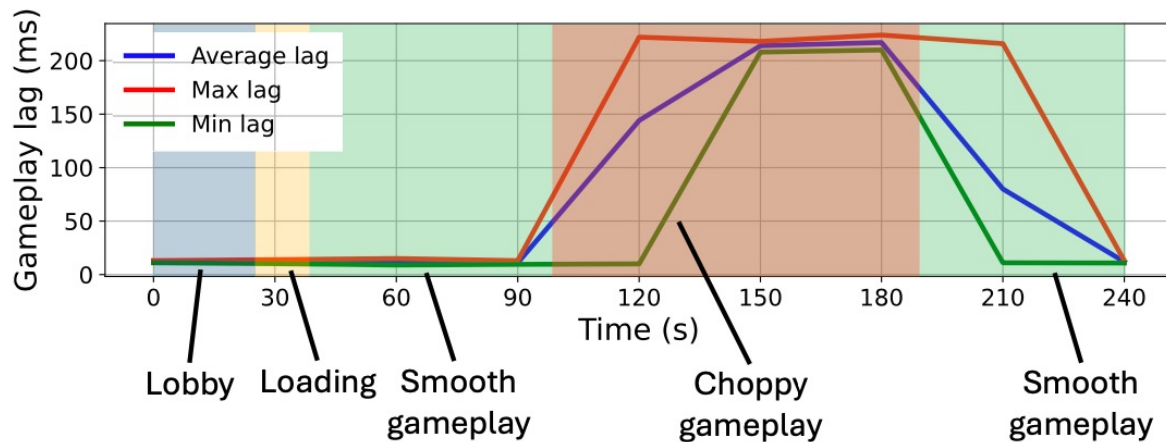
## Video stalls and startup delays

- perceived user experience
- root cause analysis

# QoE analytics for CoD gaming session



(a) A CoD gameplay session on the user device.



## □ Game lags

- instantaneous network condition
- server routing/peering quality

## □ Game states/stages

- reveals perceived QoE (gameplay – high demand; lobby/menu – low demand)

# Key takeaway

Network operators need QoE data to leverage AI-based analytics  
--> Super-Netflow provides a standardized data schema to store these data and a unified export process to exchange these info

**Any  
questions?**