

# ITRI

Industrial Technology  
Research Institute

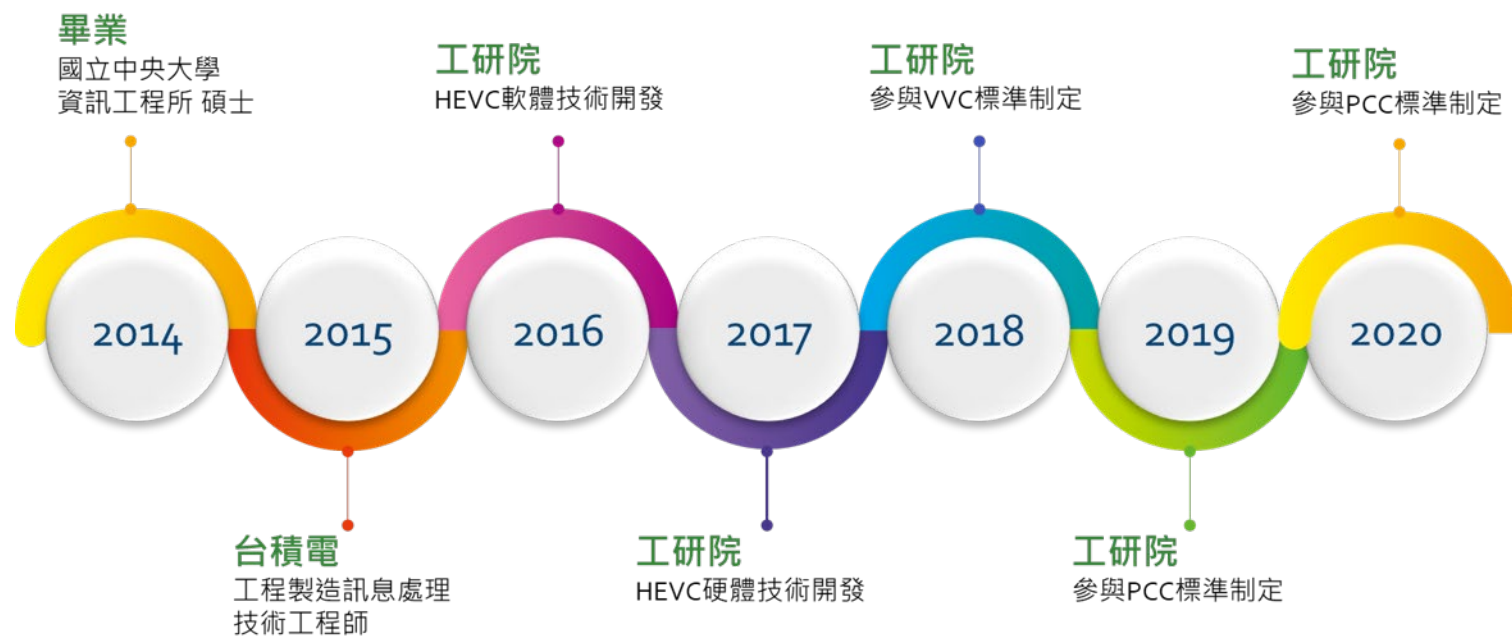
## MPEG PCC 標準進程

ITRI ICL V200 Yi-Ting Tsai

2020/05/29



# Lecturer



- **蔡懿婷** 工程師
- 2015年加入工研院
- 曾參與視訊壓縮H.265 硬體設計專案
- 目前專注於VVC與PCC標準制定

# Outline

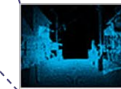
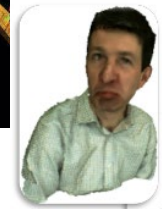
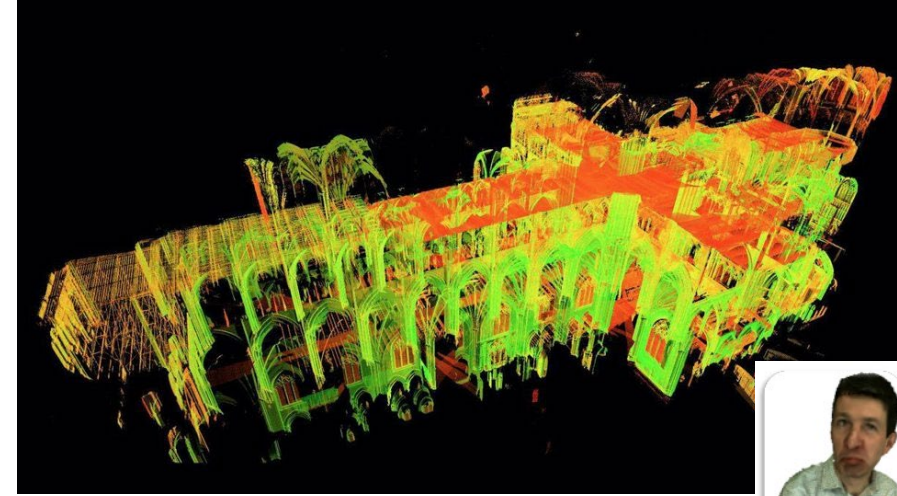
- Introduction of point cloud
- Point Cloud Compression (PCC)
- Applications of PCC
- PCC in MPEG
- V-PCC architecture and algorithm
- G-PCC architecture and algorithm
- Conclusions

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# Point cloud

- A set of 3D points
  - Not ordered
  - Without relations between them
- Each point is defined by
  - Geometry: (X, Y, Z)
  - Attribute: (R, G, B) (Y, U, V), Reflectance, transparency
- Use case
  - Cultural heritage
  - Real-time telepresence, VR
  - Geographic Information · Autonomous Navigation



300,000 ≤ Point number ≤ 70,000,000

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# Why need Point Cloud Compression?

Content Category	Test material dataset filename	Frame s	fps	# Pts	Geometry Precision	Attributes
(1) Static Objects and Scenes	Facade_00064_vox20 <sup>f</sup>	1		19,714,629	20 bit	R,G,B
	Head_00039_vox20 <sup>f</sup>	1		14,025,709	20 bit	R,G,B
	House_without_roof_00057_vox20 <sup>f</sup>	1		5,001,077	20 bit	R,G,B
	Landscape_00014_vox20 <sup>f</sup>	1		72,145,549	20 bit	R,G,B
	Palazzo_Carignano_Dense_vox20 <sup>f</sup>	1		4,203,962	20 bit	R,G,B
	Stanford_Area_4_vox20 <sup>f</sup>	1		43,399,207	20 bit	R,G,B
	ULB_Unicorn_HiRes_vox20 <sup>e</sup>	1		63,864,641	20 bit	R,G,B
(2) Dynamic objects	8i VFB-Soldier	300	30	~1,500,000	10bit	R,G,B
	basketball_player_vox11	64	30	~2,900,000	11 bit	R,G,B
	Queen	250	50	~1,000,000	10 bit	R,G,B
(3) Dynamic Acquisition	Ford_01_q_1mm <sup>g</sup>	1500	10	~100,000 / fr	18 bit	I
	qnxadas-motorway-join <sup>h</sup>	500		~32,000 / fr	18 bit	I
	citytunnel_q1mm <sup>i</sup>	1		19,948,121	21 bit	R,G,B, I
	overpass_q1mm <sup>i</sup>	1		5,255,920	20 bit	R,G,B, I
	tollbooth_q1mm <sup>i</sup>	1		7,148,516	21 bit	R,G,B, I

Landscape:  $72145549 * 20 * 3(X,Y,Z) * 3(R,G,B) = 12986198820(\text{bits}) \Rightarrow 1.5 \text{ G}$

Soldier:  $1500000 * 300(\text{frames}) * 10 * 3(X,Y,Z) * 3(R,G,B) = 40500000000(\text{bits}) \Rightarrow 4.7 \text{ G}$

Ford:  $100000 * 1500(\text{frames}) * 18 * 3(X,Y,Z) * 1(I) = 12986198820(\text{bits}) \Rightarrow 965 \text{ MB}$

2D 4K image:  $4096 * 3112 * 8(\text{Prec}) * 3(R,G,B) = 305922048(\text{bits}) \Rightarrow 37 \text{ MB}$

# Point Cloud Compression

## Geometry-based Point cloud compression

- Cat 1: Static object



- Cat3: Dynamic Acquisition



## Video-based Point cloud compression

- Cat2: Dynamic object





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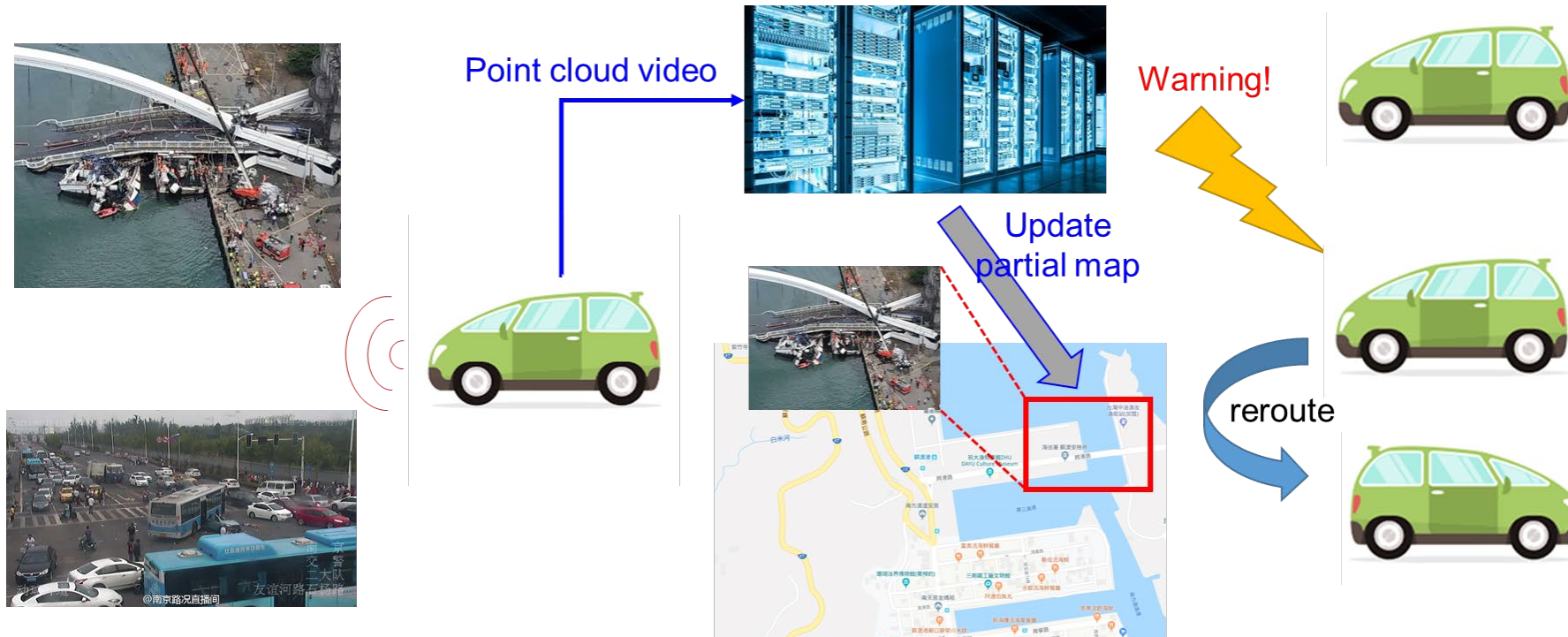
# Where and how V-PCC can be used?

- Reduce the storage requirements at the server
- Reduce the traffic exchanged between the client and server



# Where and how G-PCC can be used?

- Reduce the storage requirements at the server
- Reduce the traffic exchanged between the client and server



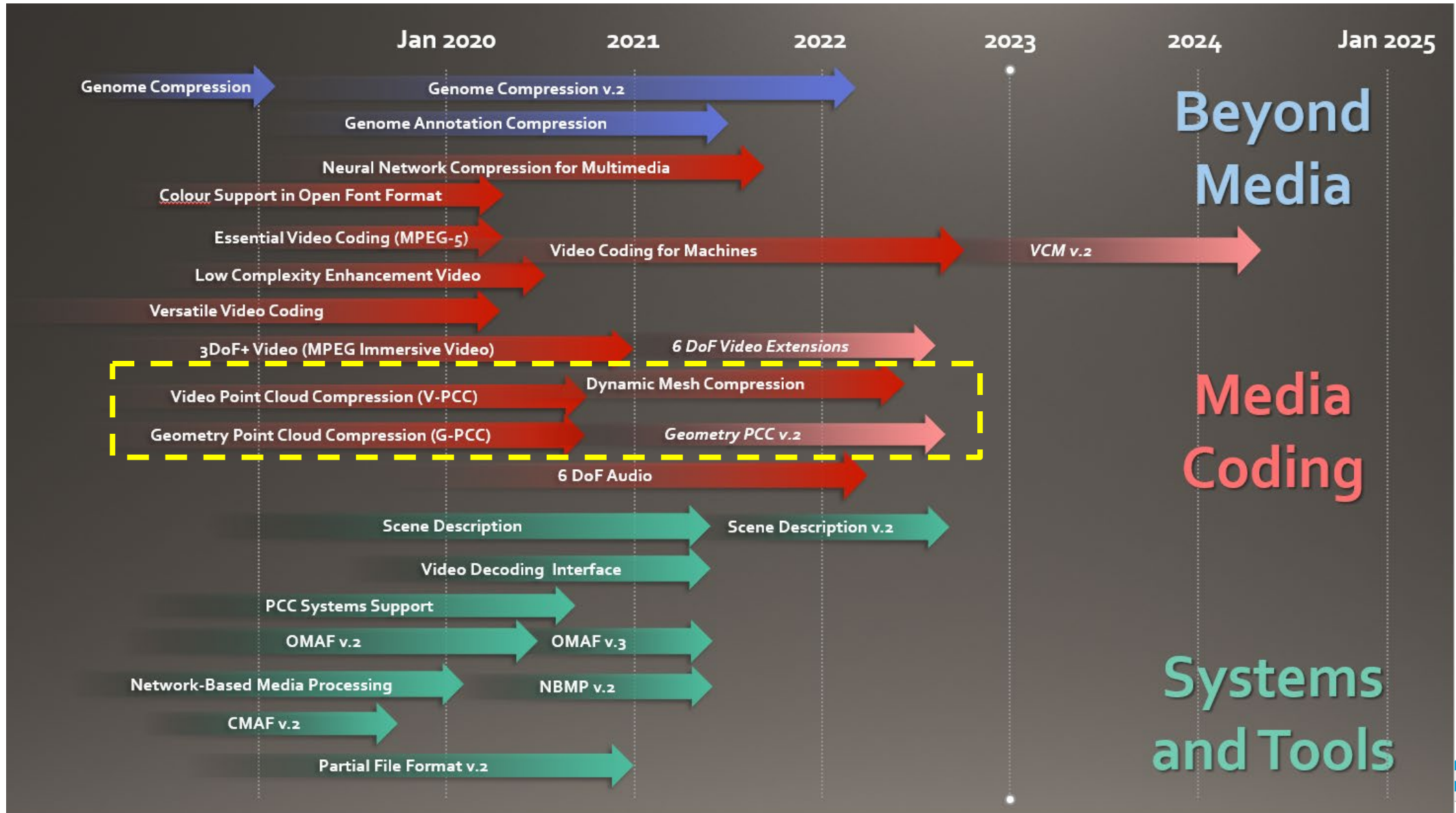
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# Scope of PCC

- **Lossy compression:** parameter control of the bitrate shall be supported.
- **Lossless compression:** the reconstructed data shall be mathematically identical to the original one.
- **Progressive and/or scalable coding:** it shall be possible to first decode a coarse point cloud and then refine it.
- **View-dependent decoding, spatial random access:** it shall be possible to first decode the point-cloud corresponding to a region.
- **Temporal random access** shall be possible.
- Compression shall support encoding and decoding with **low complexity, low latency and/or real-time implementation**
- Compression should enable **parallel encoding and decoding.**

# MPEG timeline



# Participants



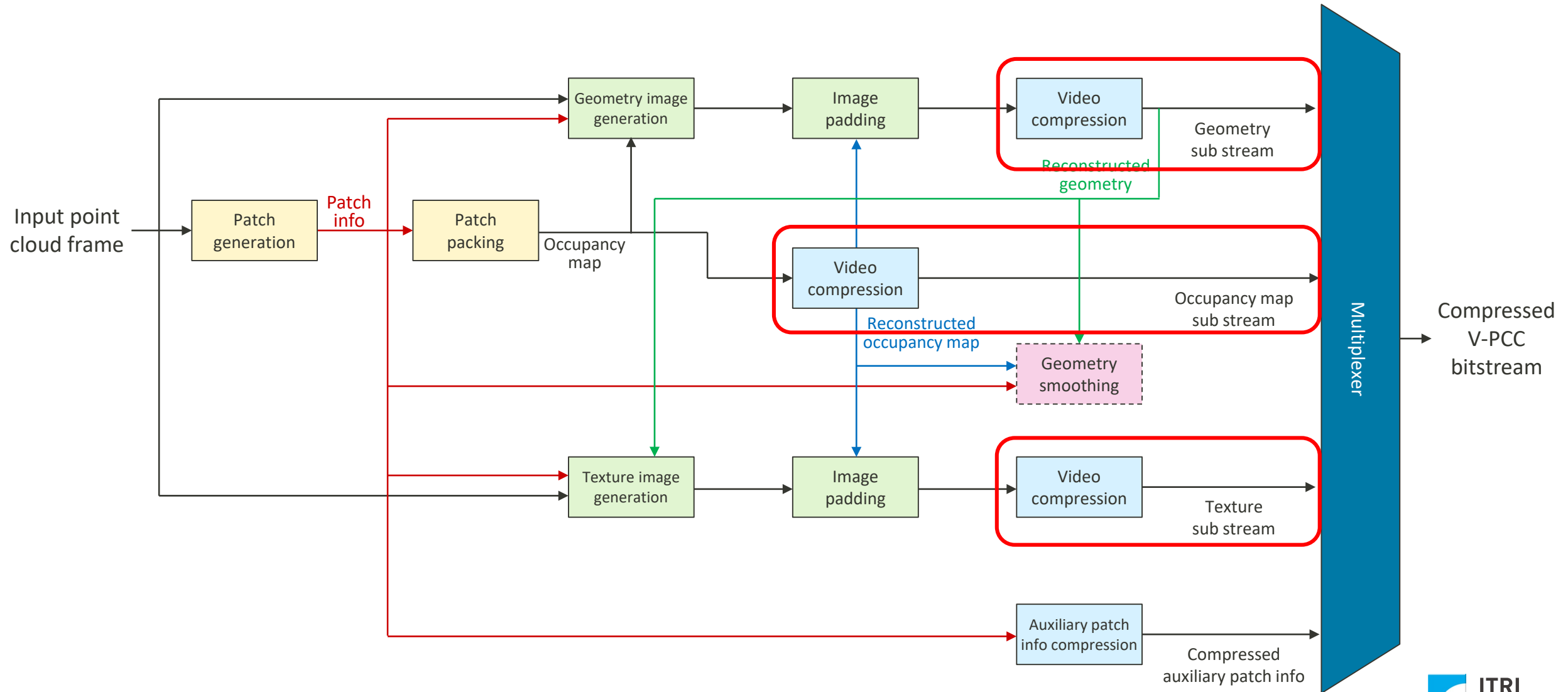
36 organizations

# Outline

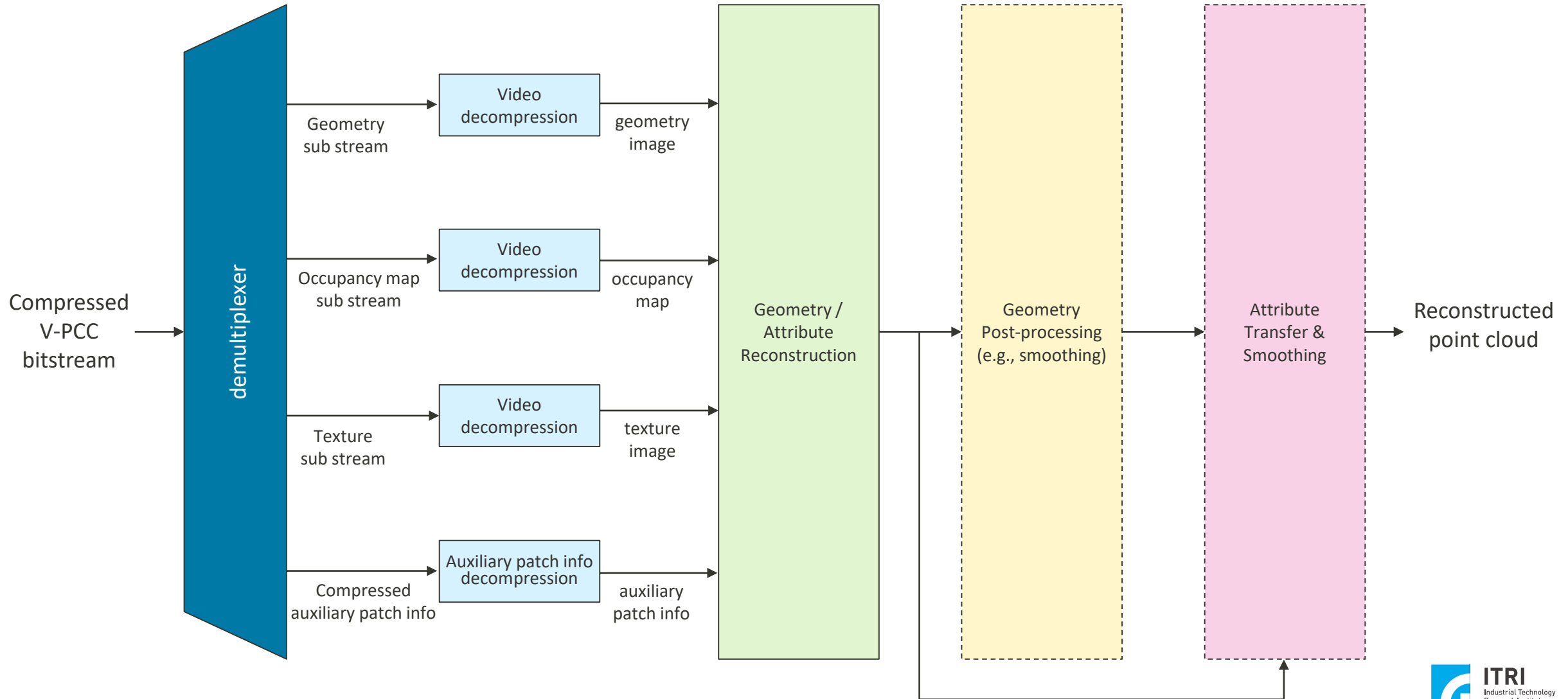
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# V-PCC architecture

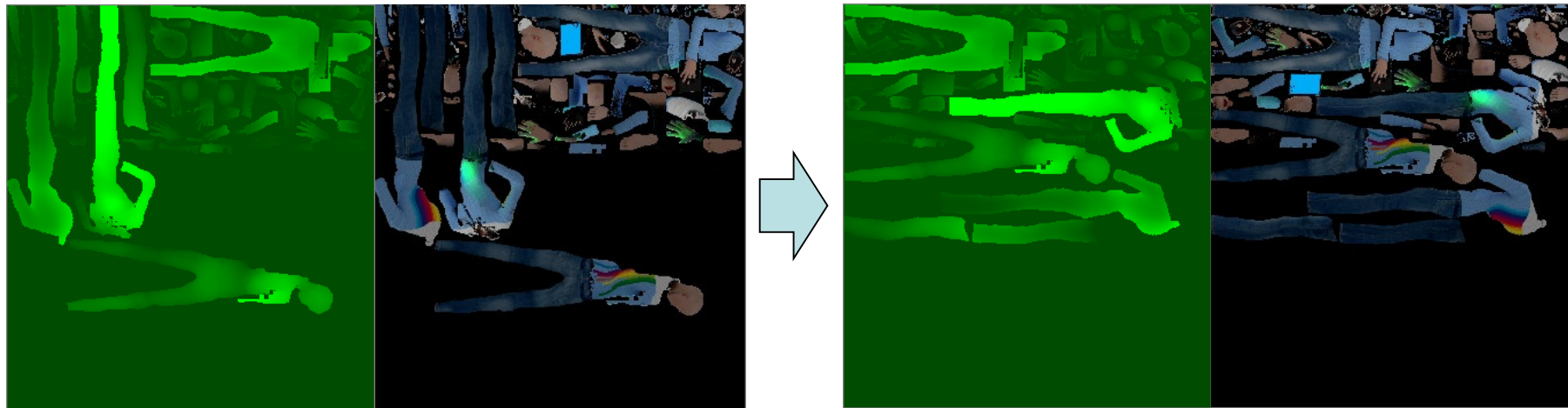


# V-PCC architecture



# V-PCC patch rotation

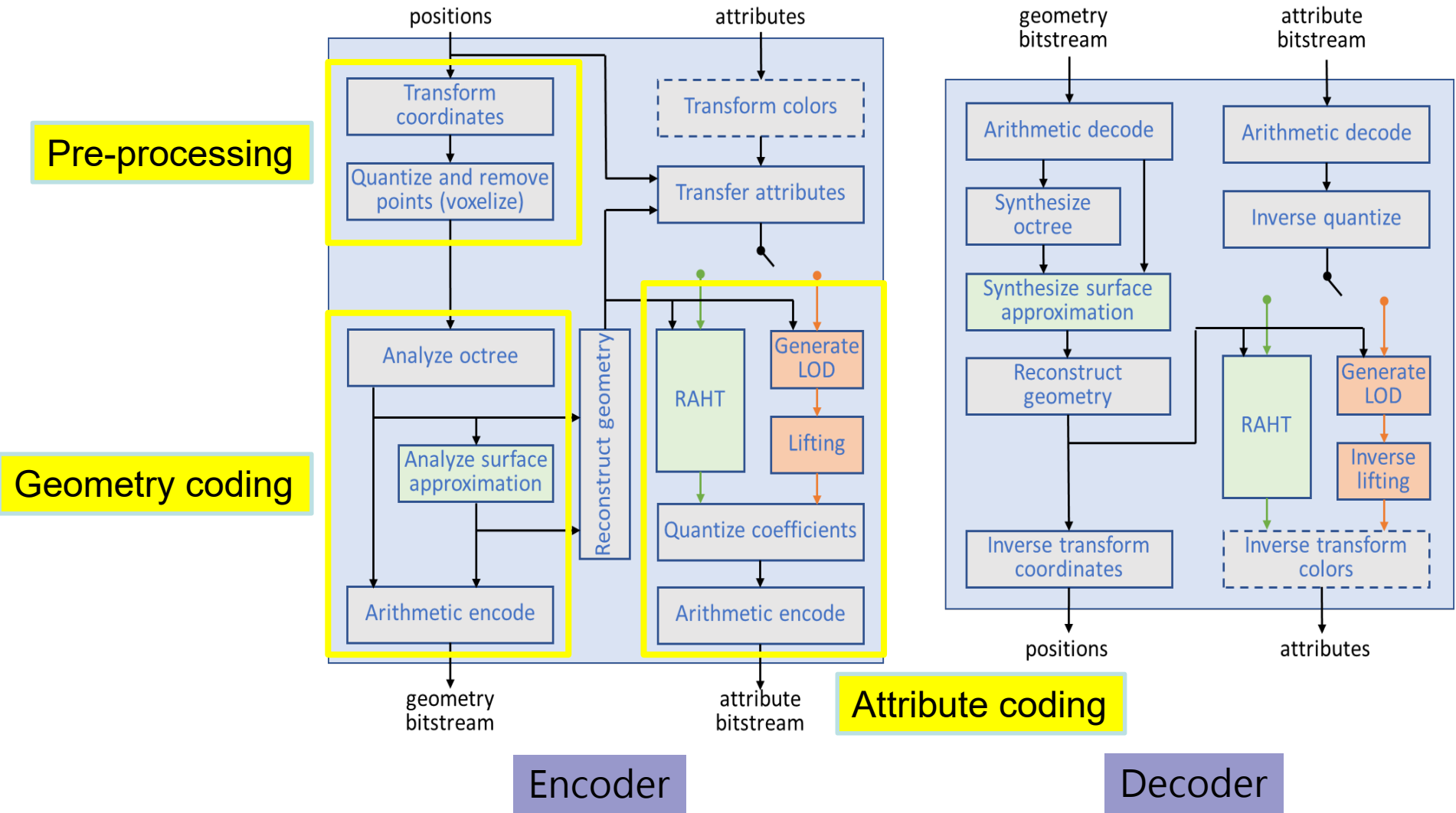
- In order to achieve the compact patch packing on 2d surface flexible patch orientation is allowed.
- 8 different orientation models are allowed
  - patch rotated by 0, 90, 180 and 270 degrees, and the mirror image of all those patches.



# Outline

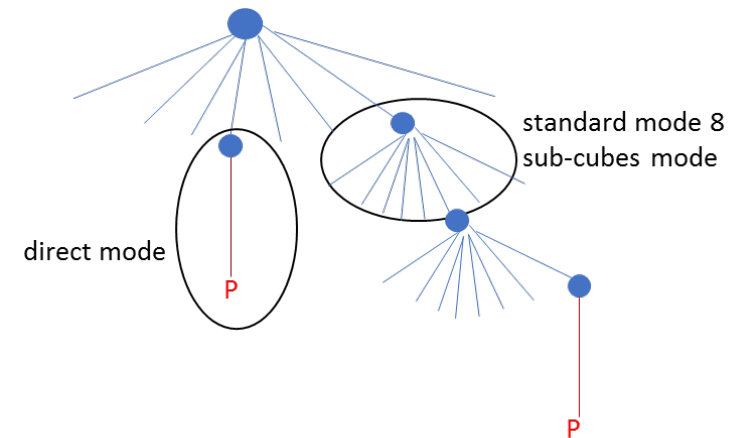
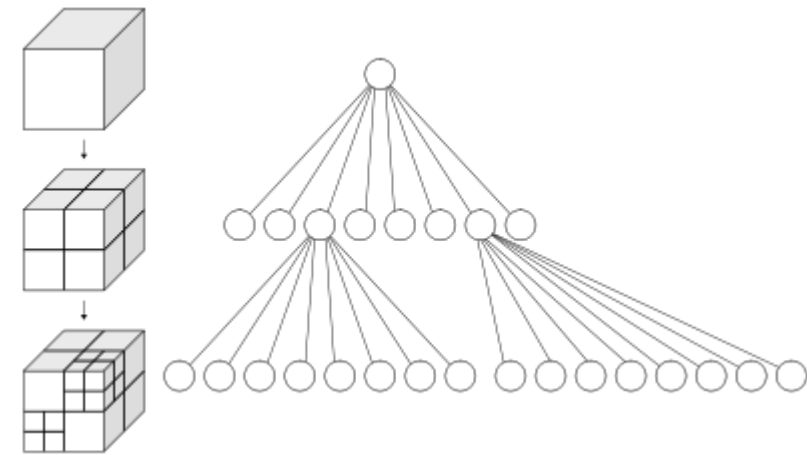
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# G-PCC architecture



# G-PCC octree geometry coding

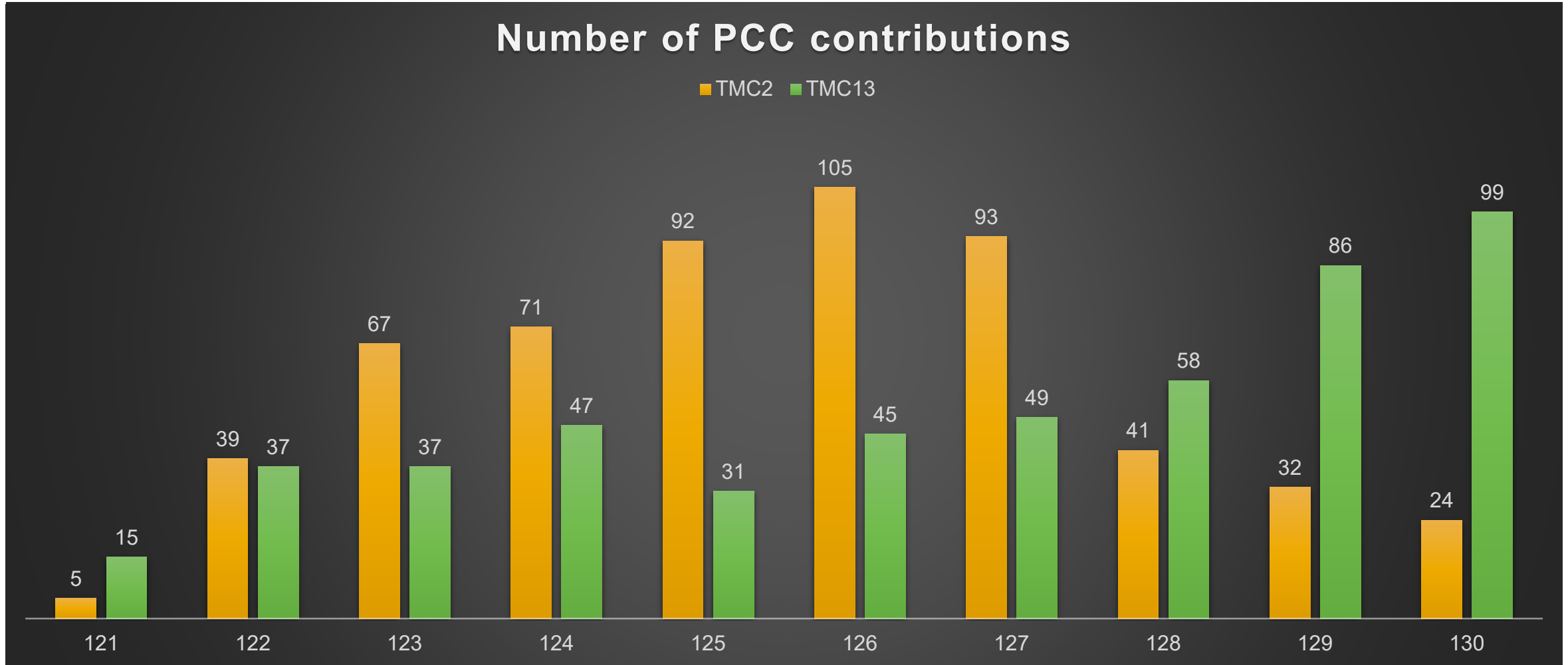
- Cubical axis-aligned bounding box
- Recursively subdividing bounding box
- 8-bit occupancy code
  - 1-bit value with each sub-cube
  - 1-> sub-cube is occupied(contain point)
  - 0-> sub-cube is unoccupied(empty)
- Direct Coding Mode(DCM)
  - For isolated points, directly coding point coordinates.
  - Depends on information coming from the parent node itself or the neighbours of the parent node



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# Contributions in PCC meeting

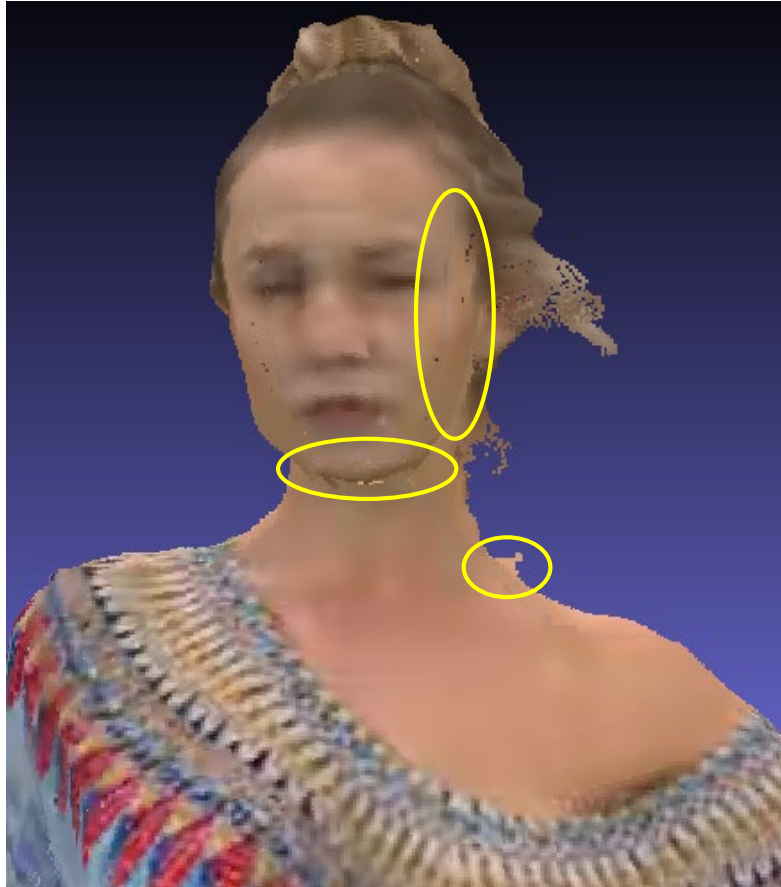




# Performance evaluation

Original sequence	Original sequence size	Compressed sequence size
Landscape_00014_vox20	1.2G	<b>R6: 1132329744 bits = 135 MB (compression ratio : 9)</b> R5: 913800720 bits = 108 MB R4: 536925720 bits = 64 MB R3: 310054624 bits = 37 MB R2: 21216744 bits = 2.5 MB R1: 4127256 bits = 0.5 MB
8i VFB-soldier	4.7G	<b>R5: 352724576 bits = 42 MB (compression ratio : 114)</b> R4: 199401576 bits = 24 MB R3: 115656200 bits = 14 MB R2: 69553256 bits = 9 MB R1: 43624688 bits = 6 MB
Ford_01_q_1mm	965MB	<b>R6: 2478513712 bits = 295 MB (compression ratio : 3)</b> R5: 2009785656 bits = 239 MB R4: 1185937496 bits = 141 MB R3: 746576376 bits = 88 MB R2: 189917080 bits = 22.6 MB R1: 78263392 bits = 9.3 MB

# Performance evaluation



compressed (lower quality)



Compressed(higher quality)

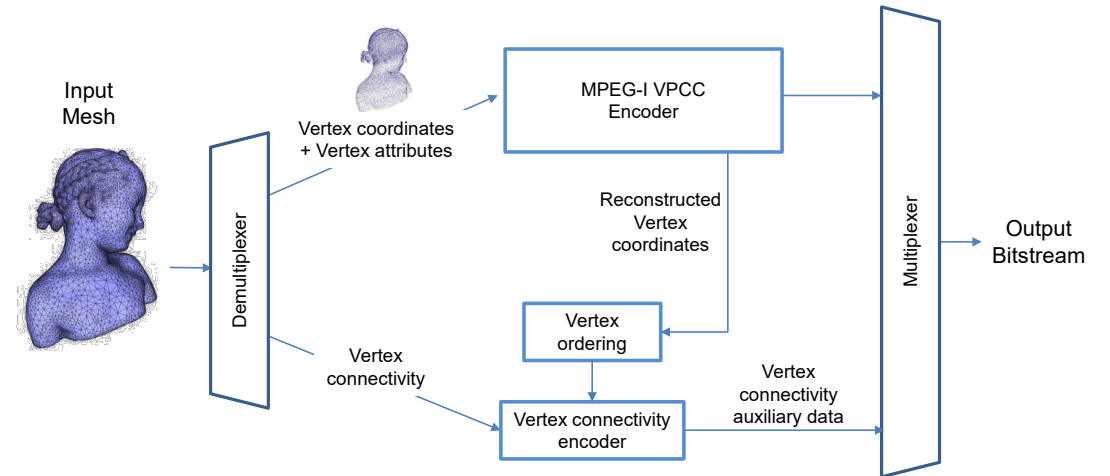


uncompressed

# Future works

- V-PCC Future works

- Mesh coding
- Convergence with Metadata for Immersive Video



- G-PCC Future works

- Inter prediction
- Convergence of attribute coding



# Thank You!



**INNOVATING A BETTER FUTURE!**