# Point Cloud Compression (in MPEG)

Immersive Media Workshop
Göteborg July 2019

Marius PREDA

MPEG 3D Graphics Chair

Institut MINES TELECOM, FRANCE

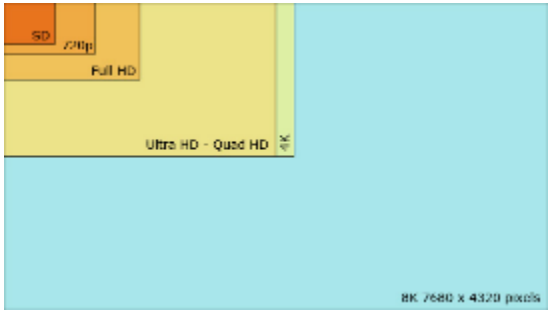
# What a Point Cloud is and why we should care about?

**Visual capture**

**Visual synthesis**

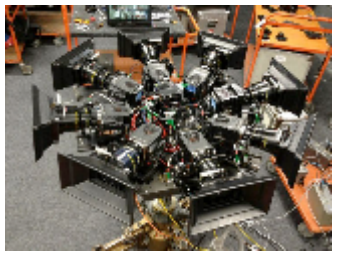
# What a Point Cloud is and why we should care about?

## Visual capture




HD, Full HD, 4K, 8K

LDR, HDR



Multi-camera

Stereoscopy

## Visual synthesis

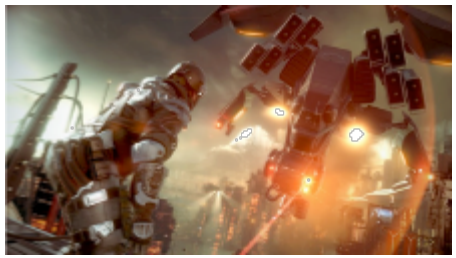


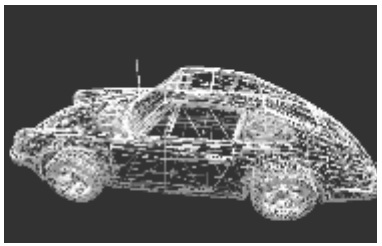
TELECOM SudParis

# What a Point Cloud is and why we should care about?

**Visual capture**

**Geometric primitives**

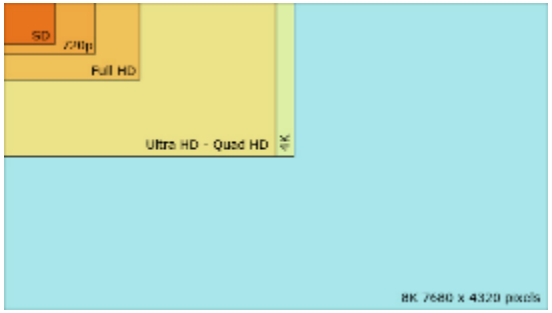





**Visual synthesis**

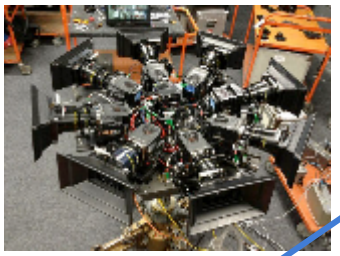
# What a Point Cloud is and why we should care about?

## Visual capture



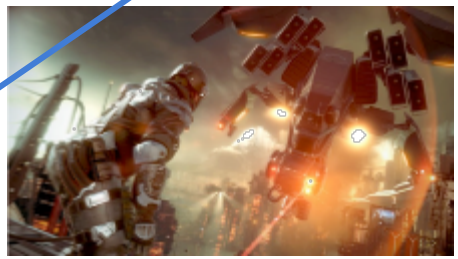

HD, Full HD, 4K, 8K

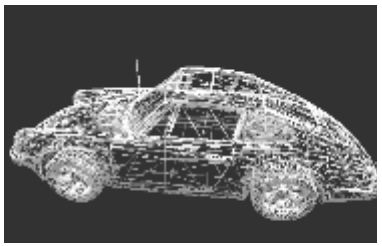
LDR, HDR

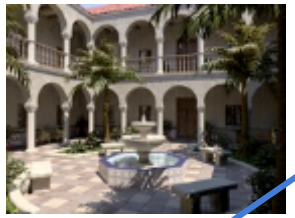


Multi-camera

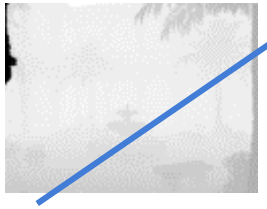
Geometric primitives







Stereoscopy



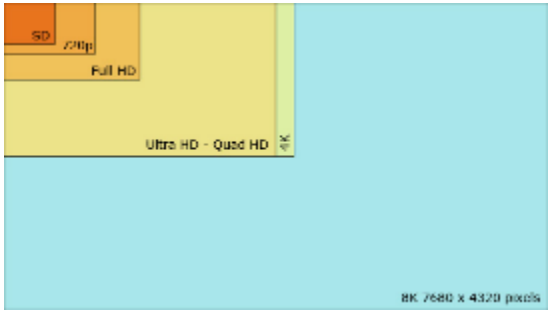

## Visual synthesis

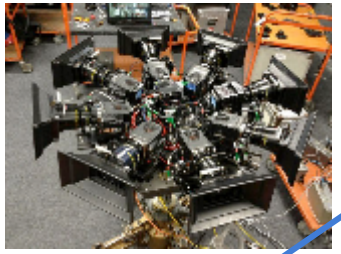


TELECOM SudParis

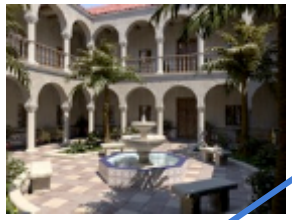
# What a Point Cloud is and why we should care about?

**Visual capture**

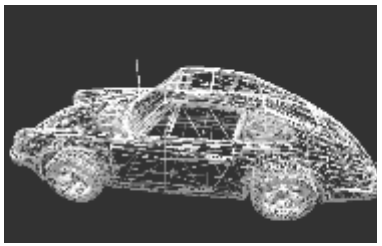


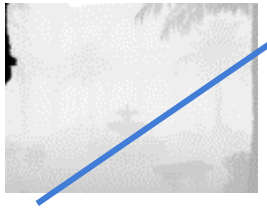



**Easy to produce**
**High quality**



**Interactivity**
**Immersion**





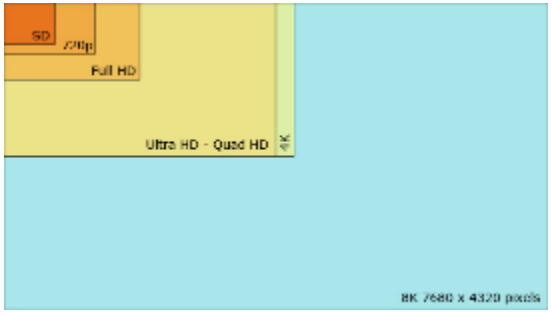

**Visual synthesis**

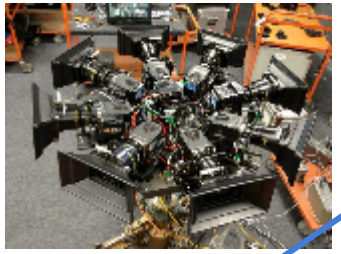


TELECOM SudParis

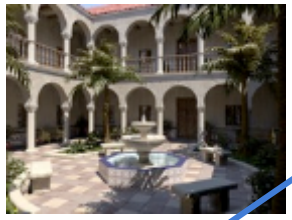
# What a Point Cloud is and why we should care about?

**Visual capture**

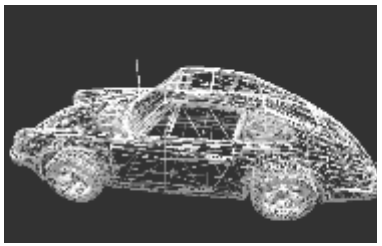


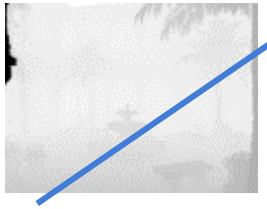



**Easy to produce**
**High quality**



**Interactivity**
**Immersion**






**Visual synthesis**



TELECOM SudParis

# What a Point Cloud is and why we should care about?

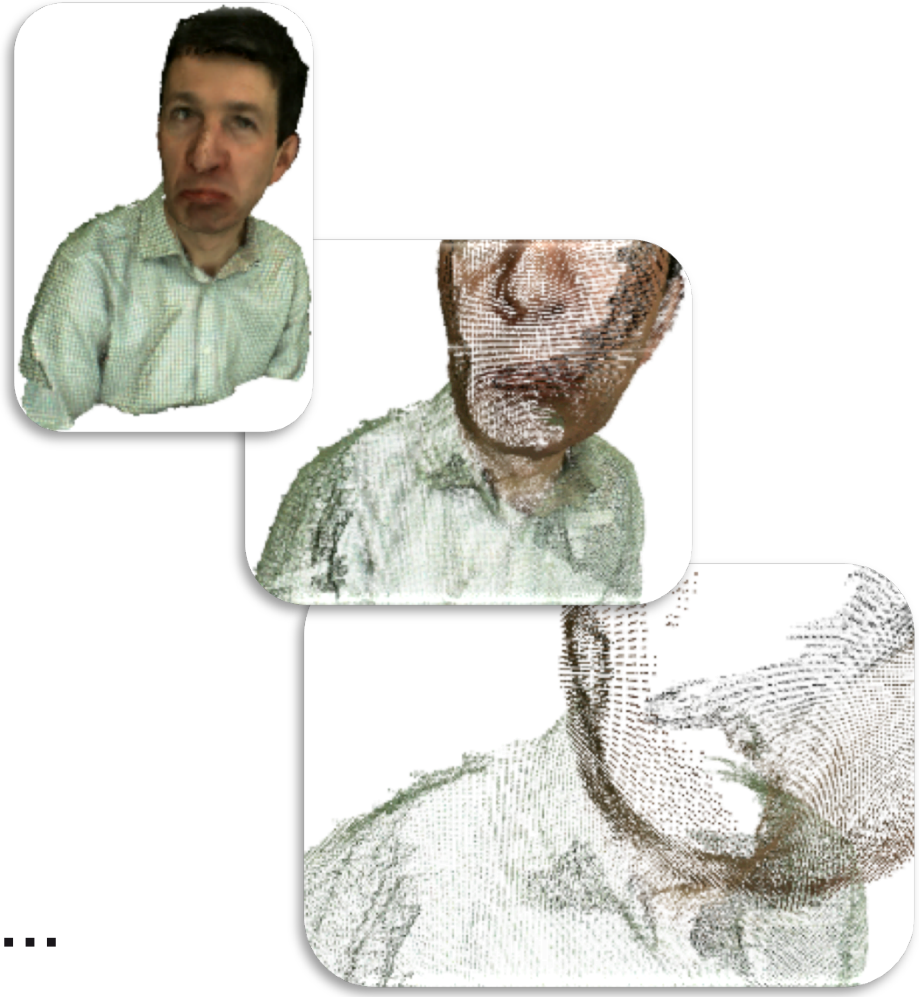
**Visual capture**

**Point Cloud –**
**a convergence between 2 worlds**

**Visual synthesis**

# Point Cloud

- A set of 3D points
  - not ordered,
  - without relations between them



- Each point is defined by
  - (X, Y, Z)
  - (R, G, B) or (Y, U, V)
  - reflectance, transparency, …

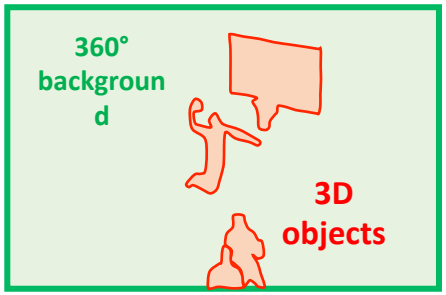
# PC

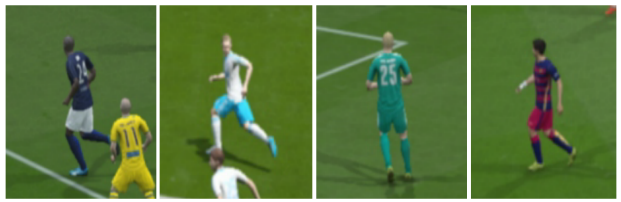
TELECOM SudParis

# PC

# Sport viewing with point clouds





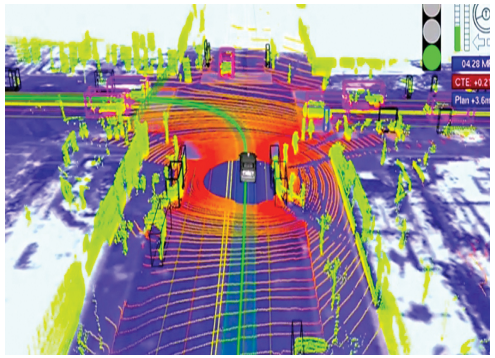



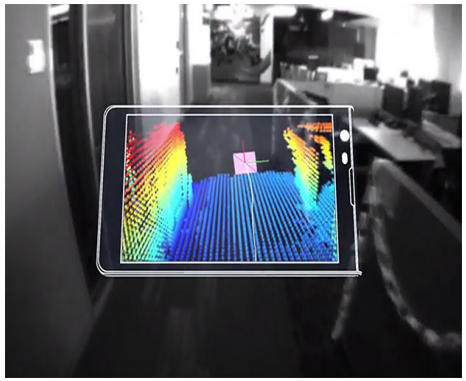
1-3 Gbps per object

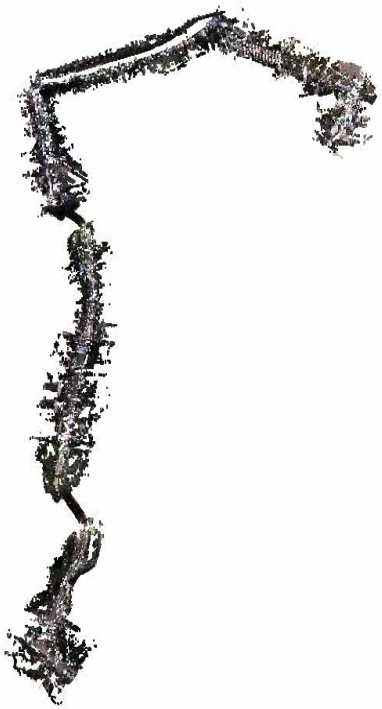
# Point Cloud

# Environment mapping for autonomous driving

- **~20 million points**
  - 2,020,734,515 bytes

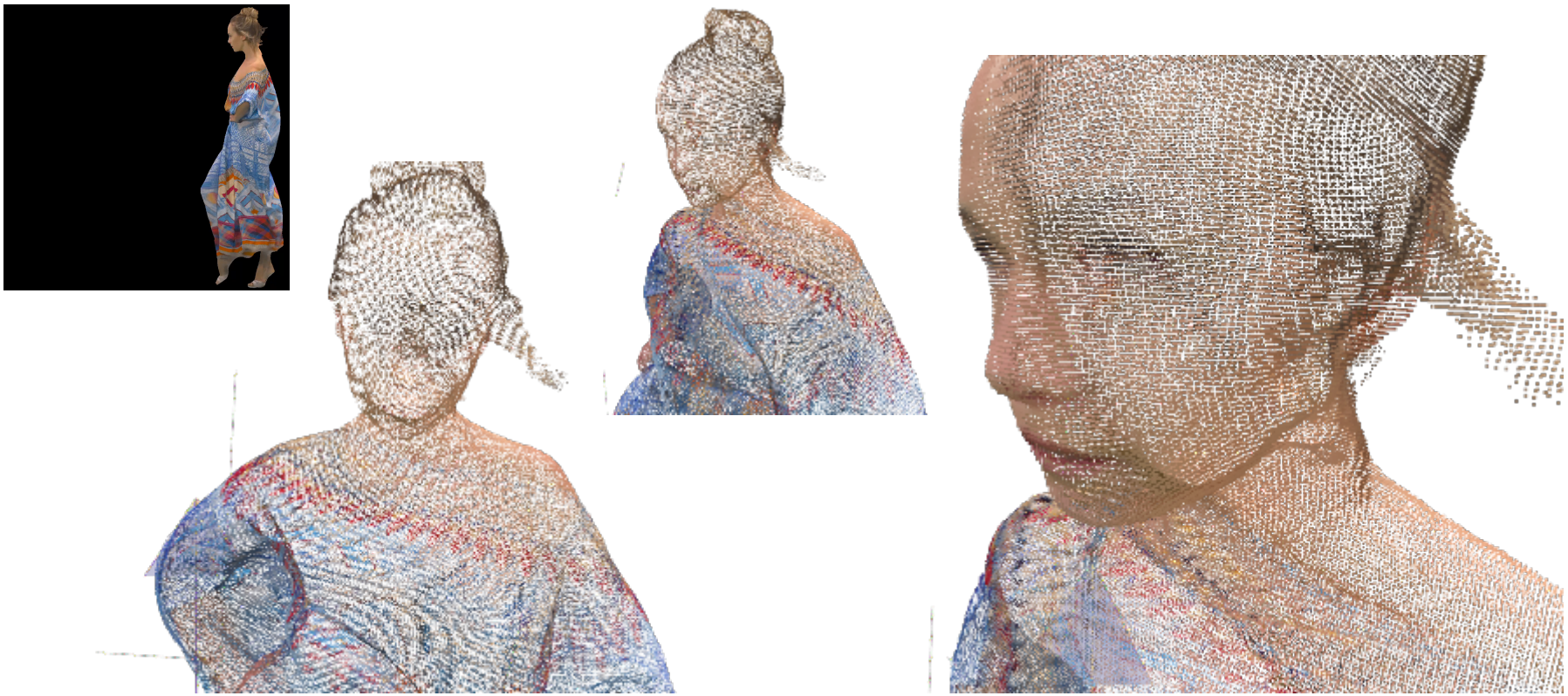






# Point Cloud

**800,000 points -> 1 000 Mbps (uncompressed)**



**Compression is required in order to make PC useful**

# Point Cloud Compression

V-PCC 01/2020

G-PCC 4/2020

2014 2015 2016 2017 2018 2019 2020

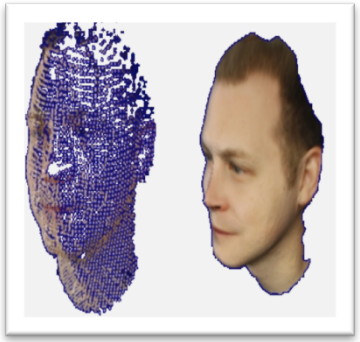
ISO/IEC JTC1/SC29 WG11 MPEG MOVING PICTURE EXPERTS GROUP

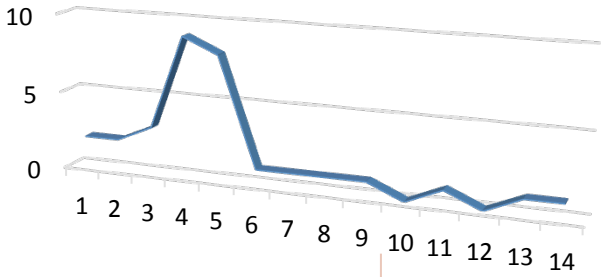
MPEG initiated the work on PCC

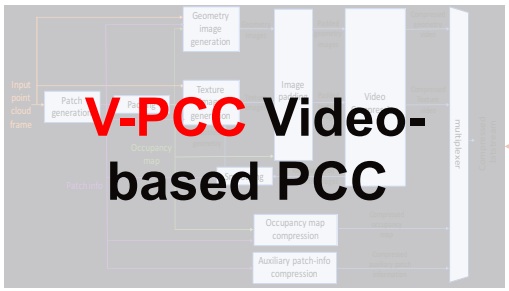
In April 2017 MPEG issued a Call for Proposals

First Committee Draft issued in October 2018

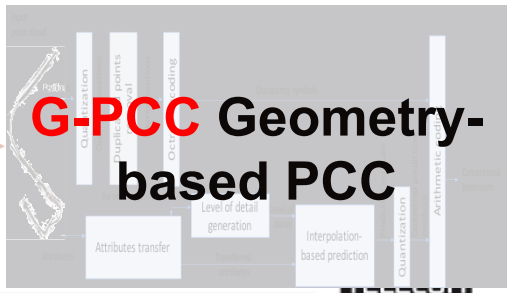
9 technology leading companies responded and MPEG evaluated them in October 2017





**V-PCC** Video-based PCC

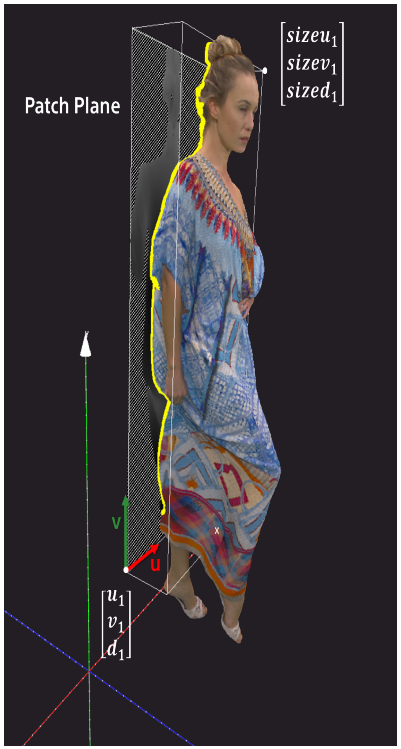


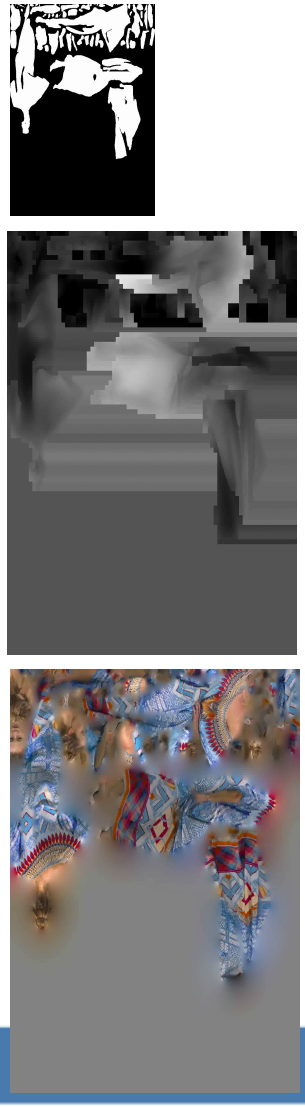
**G-PCC** Geometry-based PCC

SudParis

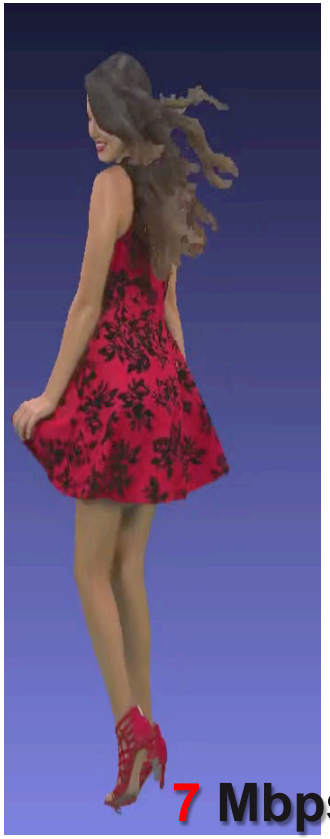
# Video-based Point Cloud Compression (V-PCC or ISO/IEC 23090-5)

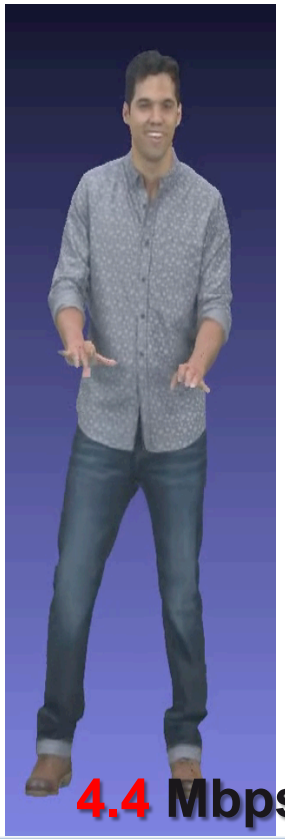
**Encoding 3D point clouds as a set of 2D videos: color, depth and occupancy map**



**100,000 points @ 30fps → 360 Mbps (uncompressed)**
**→ 1 Mbps (MPEG PCC 2018)**



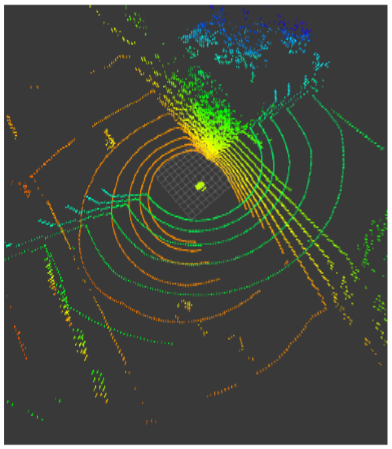



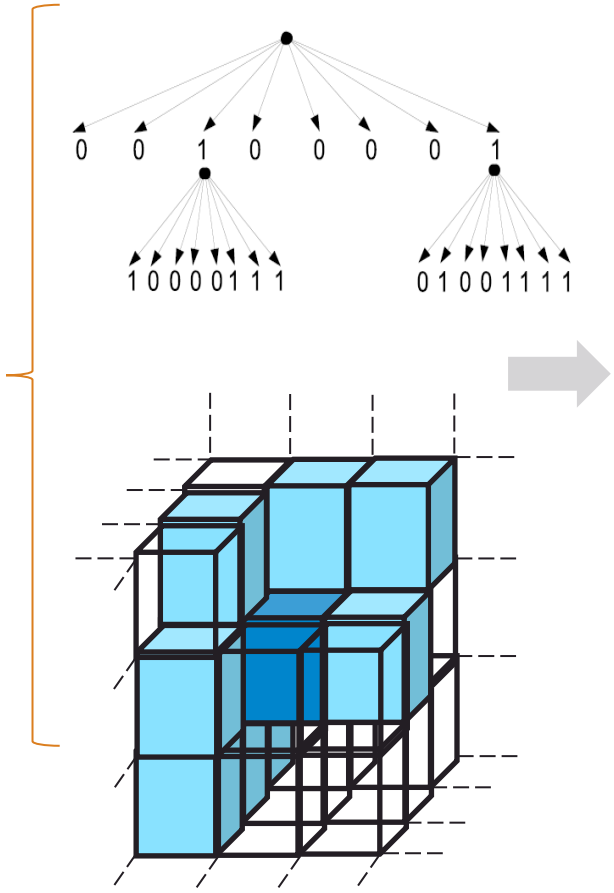

TELECOM SudParis

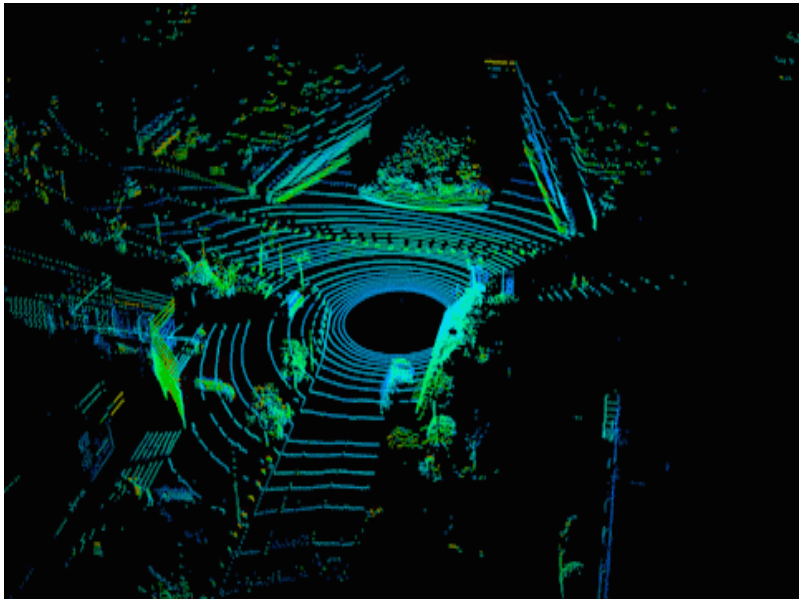
# Geometry-based Point Cloud Compression (G-PCC or ISO/IEC 23090-9)

- Encoding 3D point clouds in their native format

**100,000 points @ 10 fps → 110 Mbps (uncompressed)**

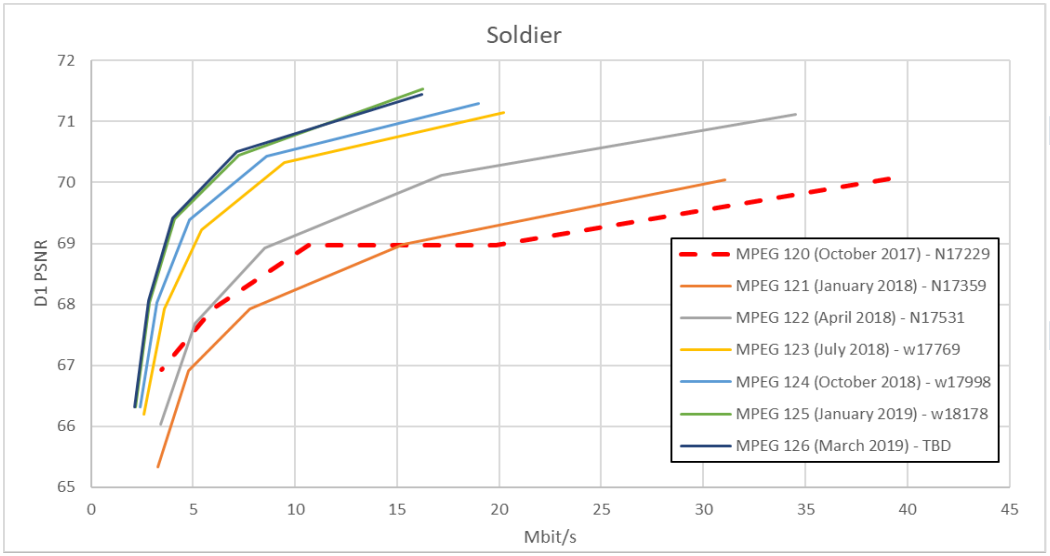




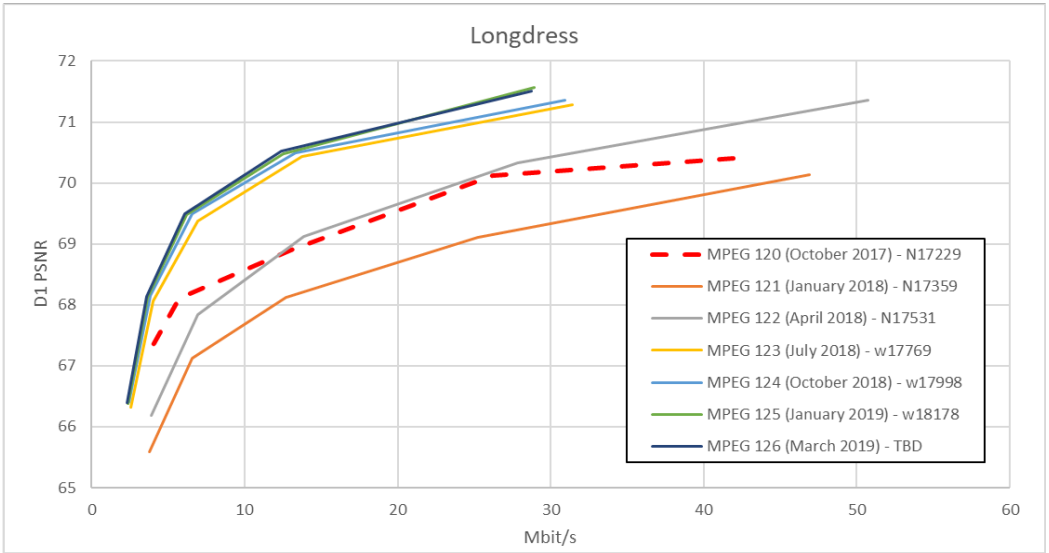



**24 Mbps (lossless)**

# About collaborations and environnement




- V-PCC progress was fast because video experts were accessible
- No other Graphics community has this privilege



# About collaborations and environnement

V-PCC 01/2020

G-PCC 4/2020

2013 2014 2015 2016 2017 2018 2019 2020

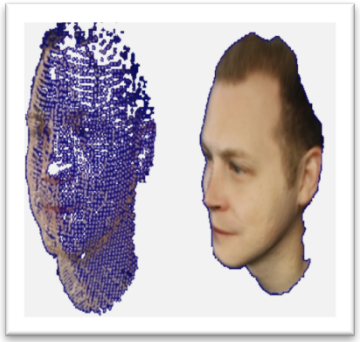
**Rufael had an idea**

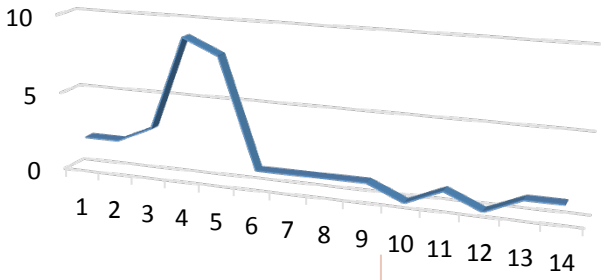
**MPEG initiated the work on PCC**

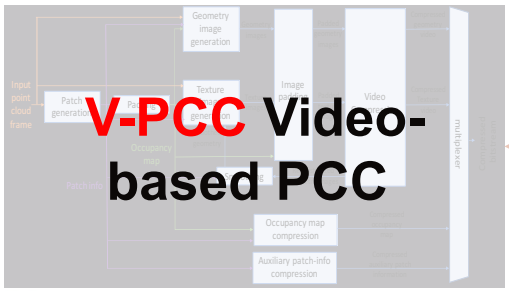
**In April 2017 MPEG issued a Call for Proposals**

**First Committee Draft issued in October 2018**

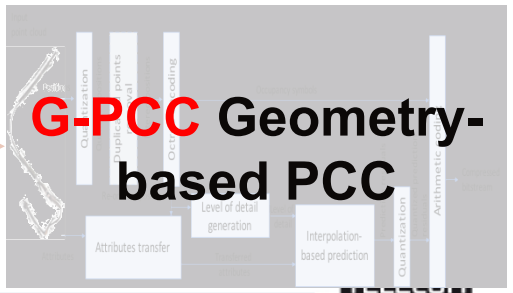
**9 technology leading companies responded and MPEG evaluated them in October 2017**





**V-PCC Video-based PCC**



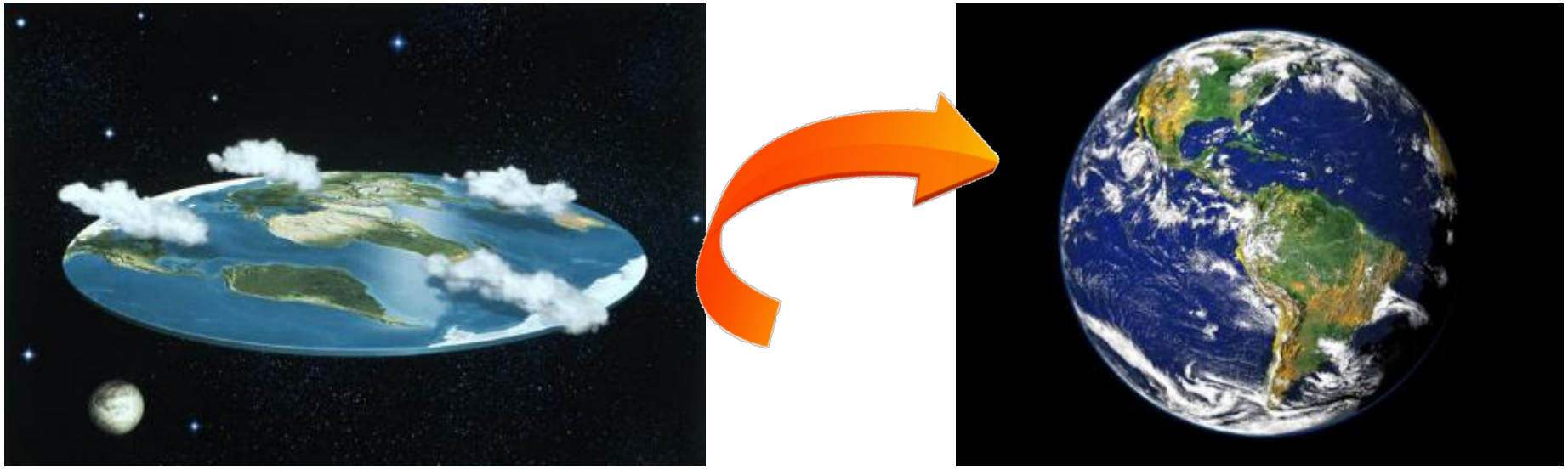
**G-PCC Geometry-based PCC**

# Conclusion

- Novel capturing systems and interactive 3D viewing experiences are creating new opportunities for future networks and technologies.
- Point Cloud Compression enables interactive high quality 3D content by providing manageable bitrates and also reducing requirements in creation, transmission and rendering of 3D content.
- Furthermore, V-PCC leverages the existing hardware and software infrastructure for rapid deployment of new immersive experiences.
- PCC provides a solid framework for the convergence between natural and synthetic 3D graphics.

# Conclusion

- We are at the beginning of a new era when humanity will re-gain its third dimension in the digital space!



# Disclaimer

- Several pictures and videos used in this presentation are provided by
  - 8i,
  - Owli
  - Sony
  - Intel RealSense
  - Microsoft Hololens
  - Institut Mines Telecom