

# The role of video QoE in the Future X Network

Pablo Pérez

March 2018 VQEG Plenary Meeting

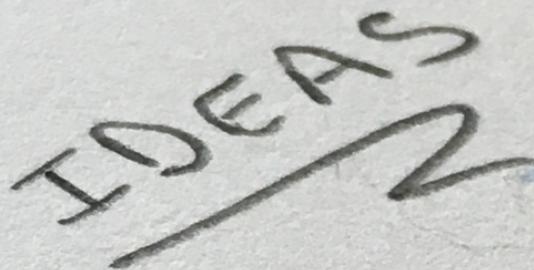
# Video and QoE in Nokia

## Presentation Outline

- Nokia Spain is one of the hotspots of Video technology within Nokia
  - Product development
  - Research (Bell Labs)
- Vision: Future X Network for the era of automation (5G and beyond)
- Public funded research projects
  - Create new Future X Network subsystems
  - QoE impact
  - Engage Nokia video experts with QoE community

Our vision:  
The future of the network

IDEAS



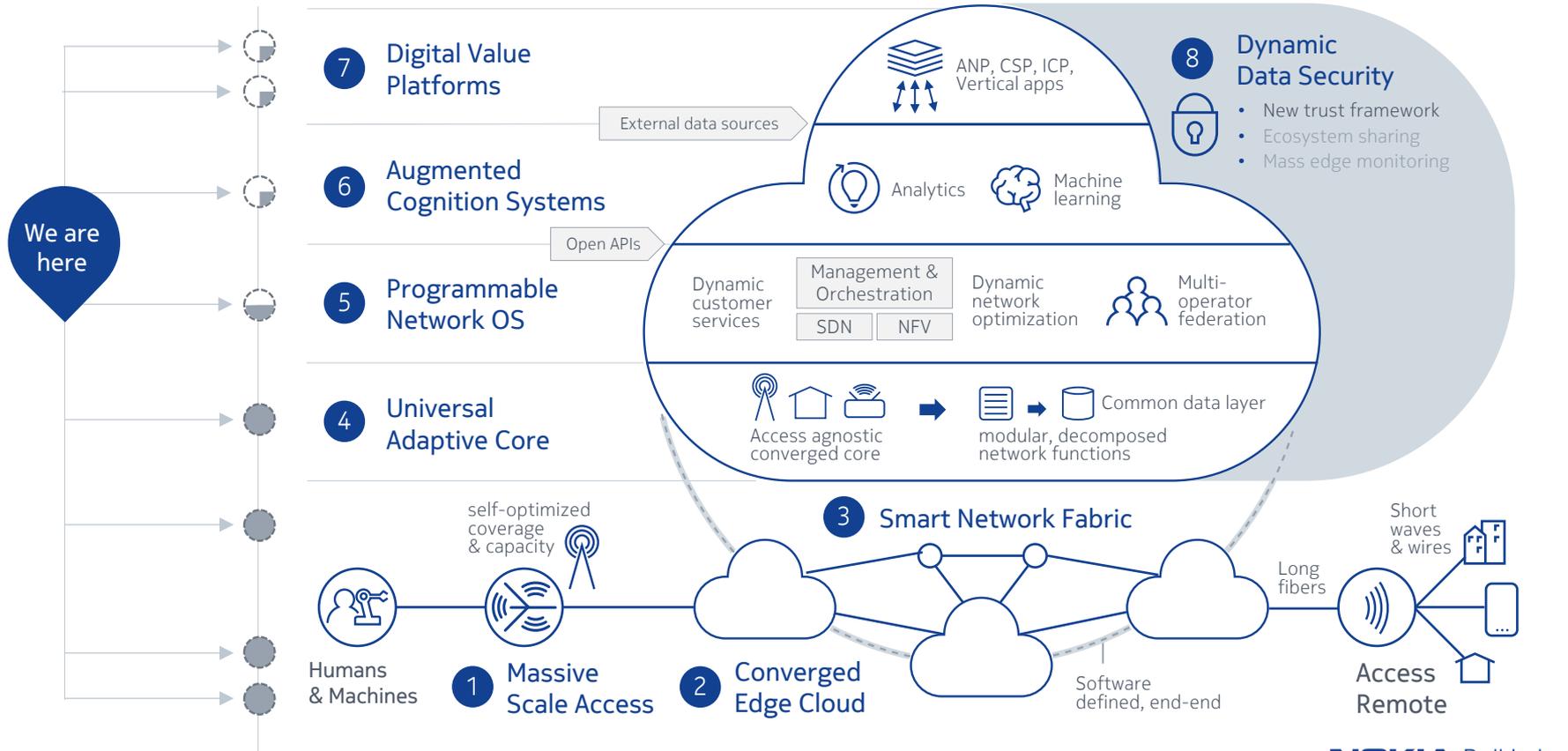
# The revolution

## Technological Revolution (def):

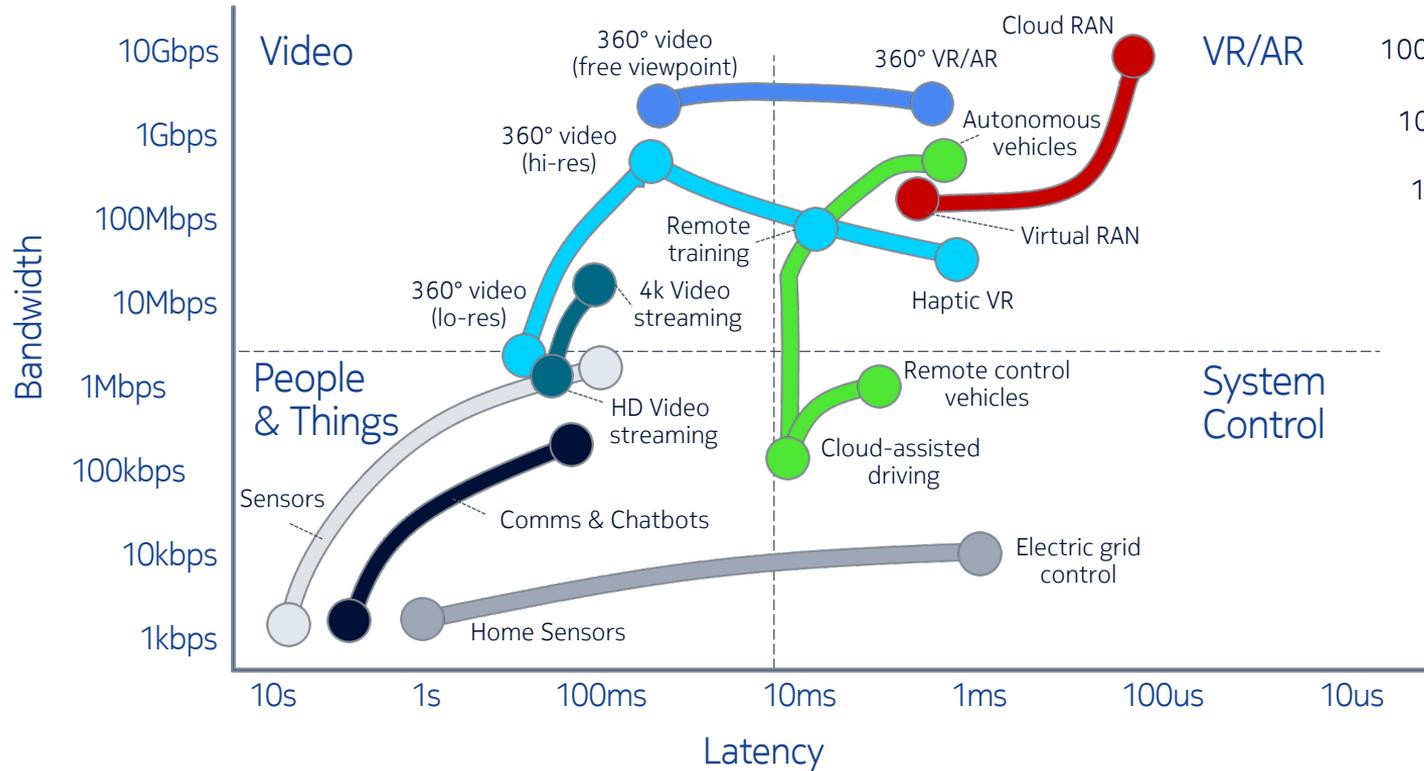
Interconnection of new systems and technologies + capacity to profoundly transform economies & society

Tech. Revolution	Enabling Technology	Connectivity
Financial (1600 – 1740)	Stocks & Bonds	Banking & Stock Market Infrastructure
1 <sup>st</sup> Industrial (1780 – 1840)	Steam Engine & Iron Production	Rail and Shipping Networks
2 <sup>nd</sup> Industrial (1880 – 1920)	Steel & Chemicals	Extended Transportation Networks Electricity & Telecom Networks
Scientific-Technical (1940 – 1970)	Analog & Digital Signal processing	Digital Communications Networks
Information (1985 – 2015)	The Web, Cloud computing & Mobile devices	Internet & Broadband Access
<b>Automation of Everything (2015 –)</b>	<b>Digital interfaces &amp; Data analysis</b>	<b>Future X Network</b>

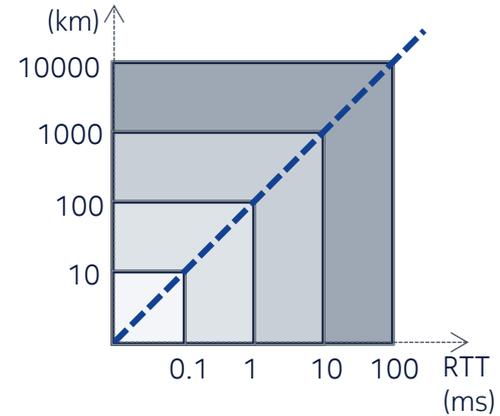
# The Future X architecture for the digital future of everything



# Latency & bandwidth matter ...



Light propagation



# What about Video Quality?



## **Visual information is (still) relevant**

- New formats (e.g. omnidirectional)
- New ways of experience (immersion, interactivity, augmentation, etc).

## **Entertainment is not the only use case**

- Domain-specific QoE:
  - Training, design, communication...
- Video Quality for Machine Learning

## **Latency is critical**

- Quality of interactivity
- Response time of quality metrics

## **Quality as a Service**

- Optimize resources in terms of QoE
- Standard and interoperable metrics



# Video research & innovation projects

And how video quality is important for them

# Creating new video pieces for the Future X Network



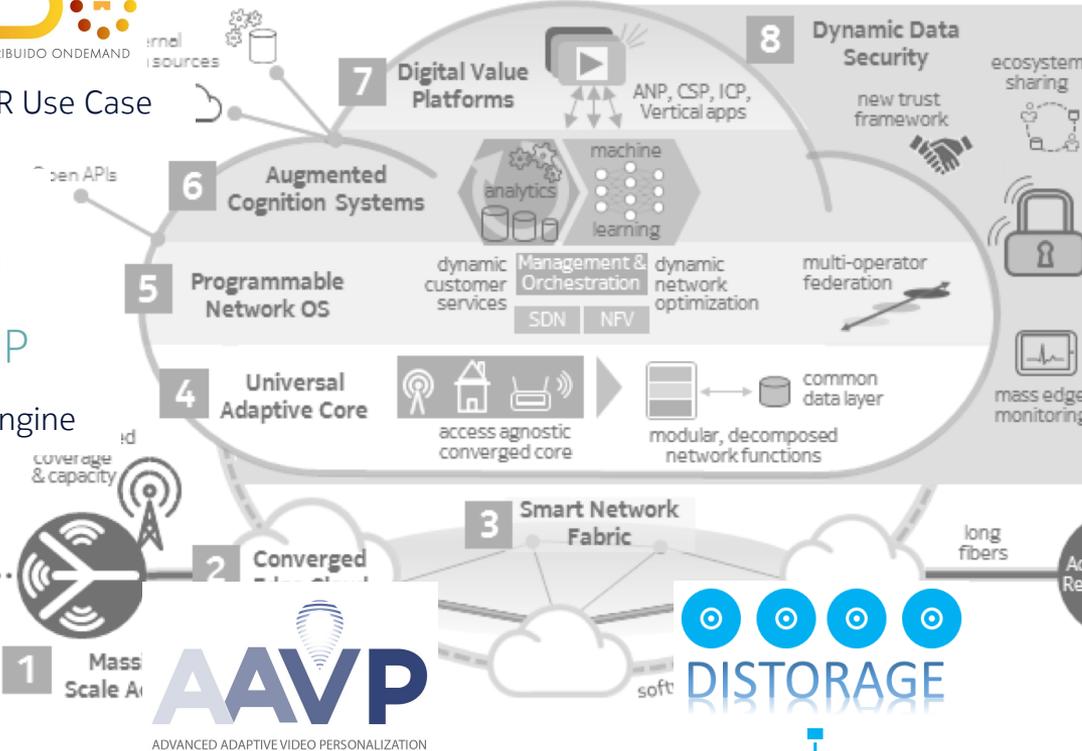
End-to-end 360VR Use Case



Transcoding Engine



Humans & Machines



Quality Monitoring

short waves & wire-



User Terminal

Edge Cloud Content Adaptation

Cloud Scalable Storage

NOKIA Bell Labs

## Monitoring segmented video

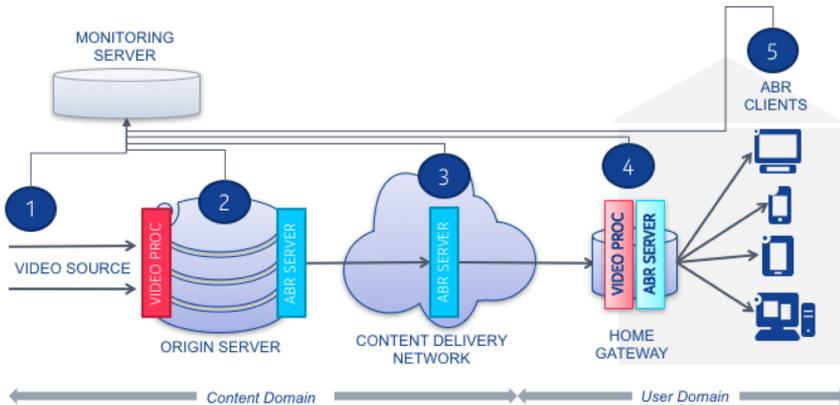
- Architecture to monitor QoE
- Identify key NR metrics
  - Cause -> objective effect -> subjective impact
- Create monitoring / assessment tools

**NORM:** NR metrics for monitoring (KQIs)

- Scalable, real-time
- Significant (understandable) for operators
- Repeatable (can be forced)

**IMG/AVHD:** develop test tools

**VQEG:** host this meeting :-)



# BUSTOP

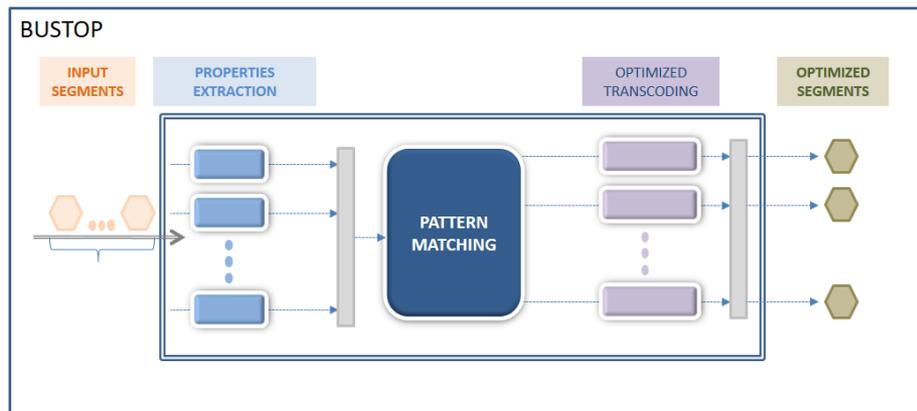
## Terminal-oriented video transcoding platform

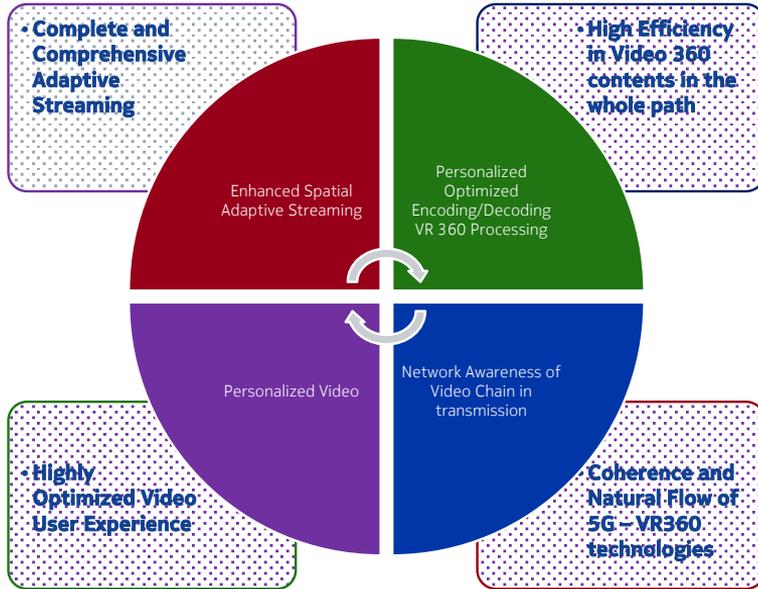


- Optimize content:
  - Network restrictions
  - User terminals / screens
- Scalable decision process & transcoding
  - Edge cloud, per-user

### SAM/AVHD/UHD:

- Device characterization (presentation #28)
- Accuracy/efficiency trade-offs for coding quality metrics





- Optimization of ABR video content for
  - 4.5G/5G topologies &
  - 360VR video content
- Edge cloud content personalization

#### IMG:

- Quality of viewport-optimized video coding (e.g. based on tiling)
  - Low-latency FR metrics

# DISTORAGE

## Highly scalable video storage platform



- Scalable storage for massive recording and streaming of video
- Distributed: redundancy and throughput
- Real-time analysis and labeling of video segments
- Ingest may be not reliable (e.g. user-generated)

### NORM:

- Content quality thresholding (accept/reject)
- Key Quality Indicators that may be added as meta-information to video storage
  - (e.g. "find me all the contents whose quality is excellent")

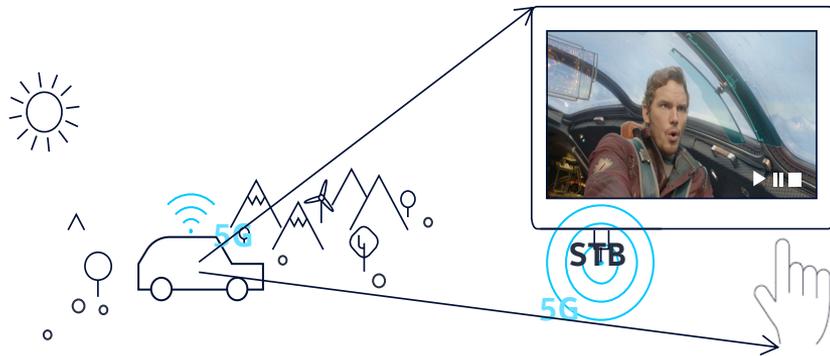


# 5GSTB

## User terminals for the future network



- HW/SW implementation of client device (“set-top-box”) for 5G mobility environments
- Adaptive streaming policies
  - Optimized for mobility (network changes)
  - Adding info from network status



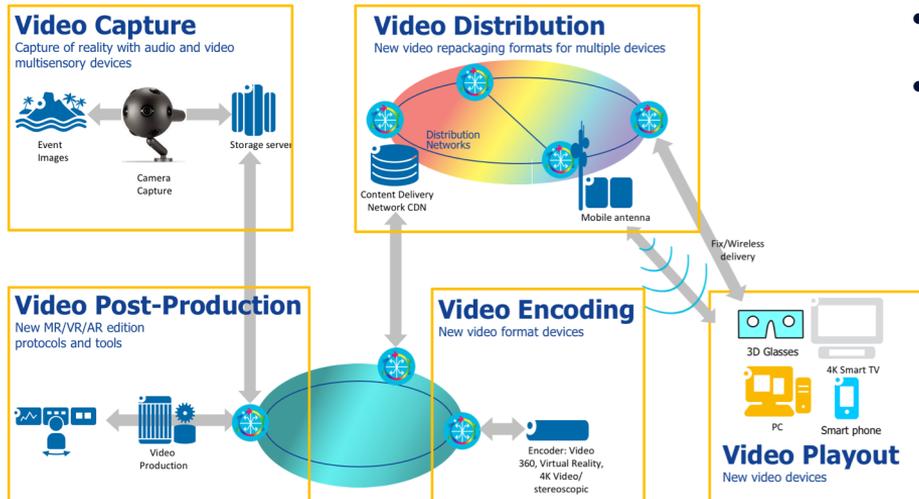
### AVHD:

- Metrics to model adaptive streaming quality
  - Can they be used as input to optimize client algorithm?
- Subjective assessment methodologies:
  - Adaptive streaming sessions
  - Mobility environments (car/train/...)

- Professional capture and production of 360VR content
- Requirements for e2e service
- Use cases: education, telemedicine...

### IMG:

- Quality of capture & production:
  - Quality of the 360VR shots
  - Stitching, projections, e
- Task-oriented evaluation for use cases
- Interaction between real and virtual world (augmented virtuality)



# ACKNOWLEDGEMENT

## PROJECT FUNDING

1. This work has been partially supported by the Ministerio de Economía, Industria y Competitividad of the Spanish Government under project RTC-2015-4133-7 (MOVISE)
2. This work has been partially supported by the Spanish Administration agency CDTI under project IDI-20170739 (AAVP)
3. This work has been partially supported by the Spanish Administration agency CDTI under project IDI-20170572 (BUSTOP)
4. This work has been partially supported by the Spanish Administration agency CDTI under project IDI-20170957 (5GSTB)
5. This work has been partially supported by the Spanish Administration agency CDTI under project IDI-20170959 (DISTRORAGE)

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