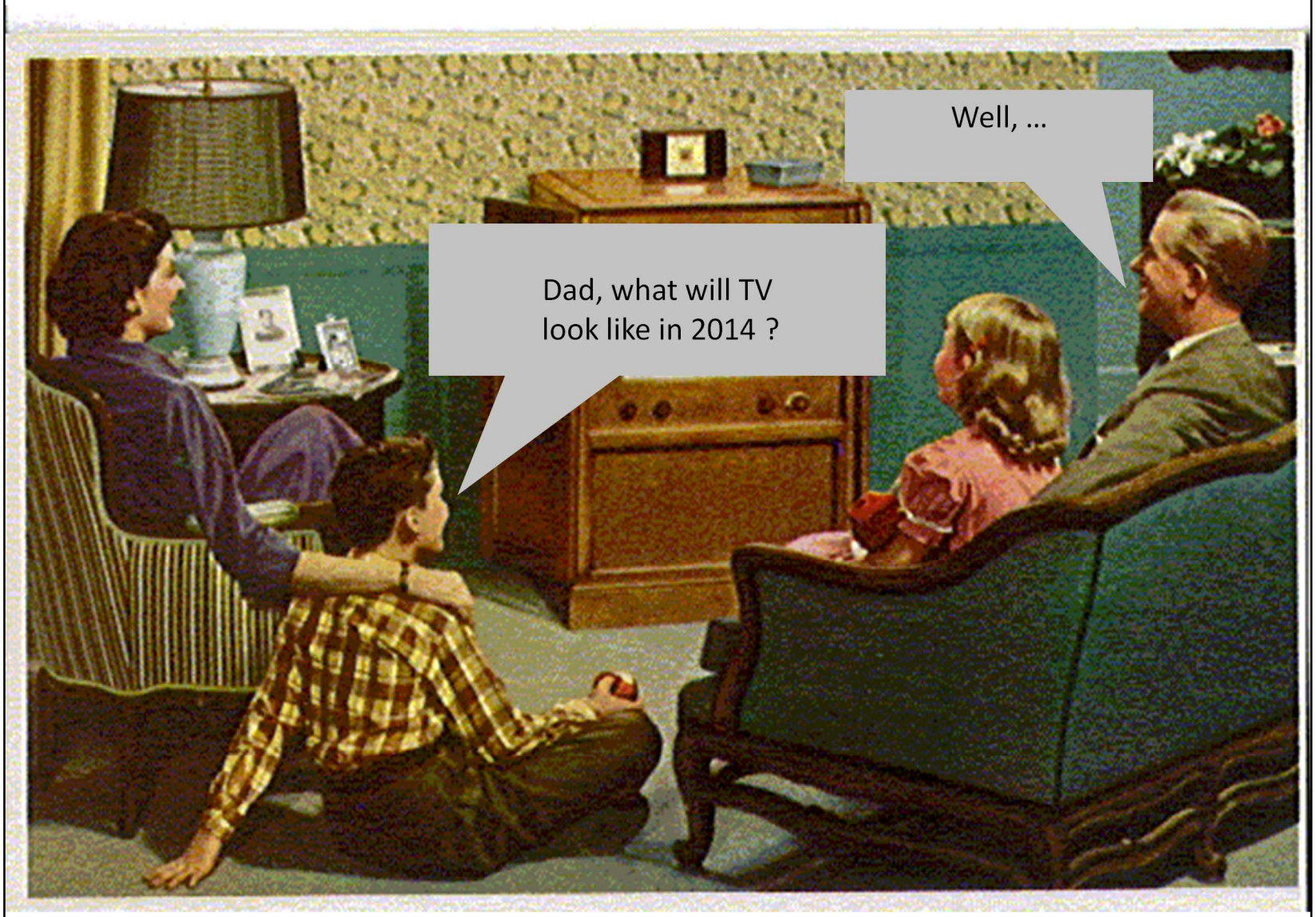

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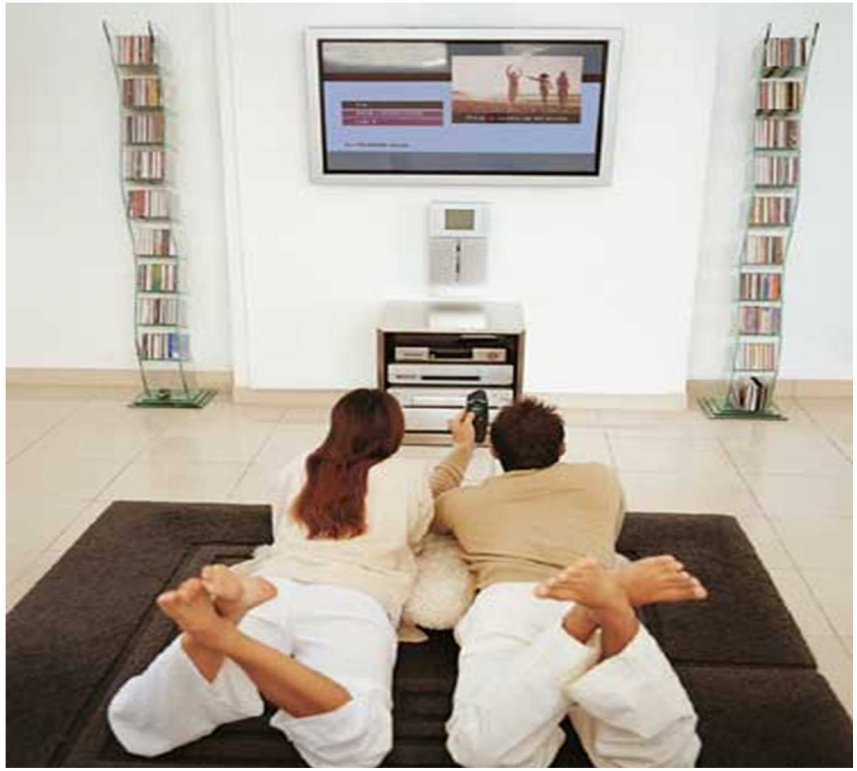
« … IT’S GOING TO BE COMPLETELY DIFFERENT… »



Decades of technical improvements, but content is still delivered to you as decided by producer

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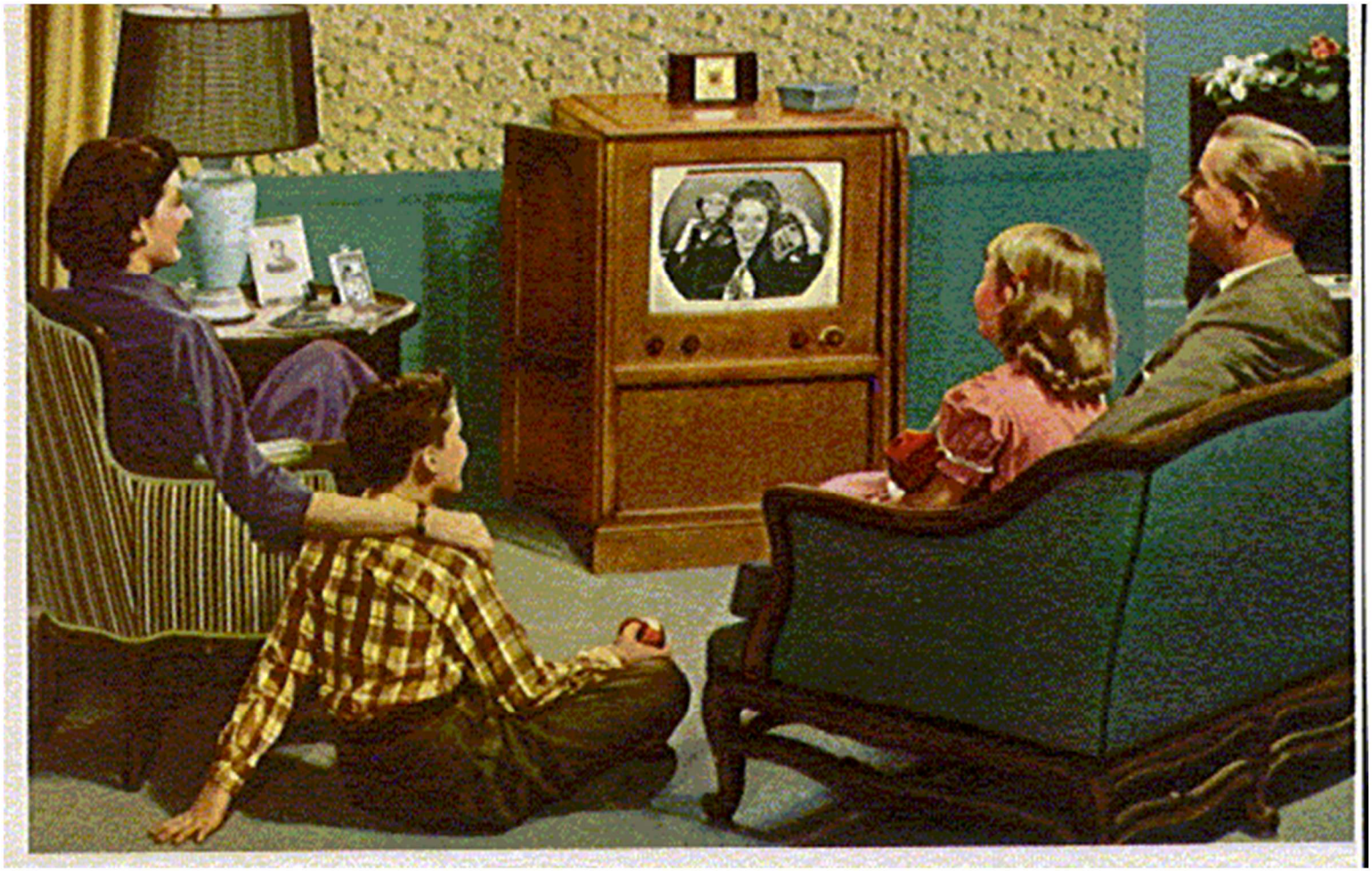
HAS OUR TV EXPERIENCE REALLY CHANGED?



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FTV *CAN* MAKE THE TV EXPERIENCE RADICALLY DIFFERENT

FTV disruption: leave complete control of the scene viewpoint up to the end user

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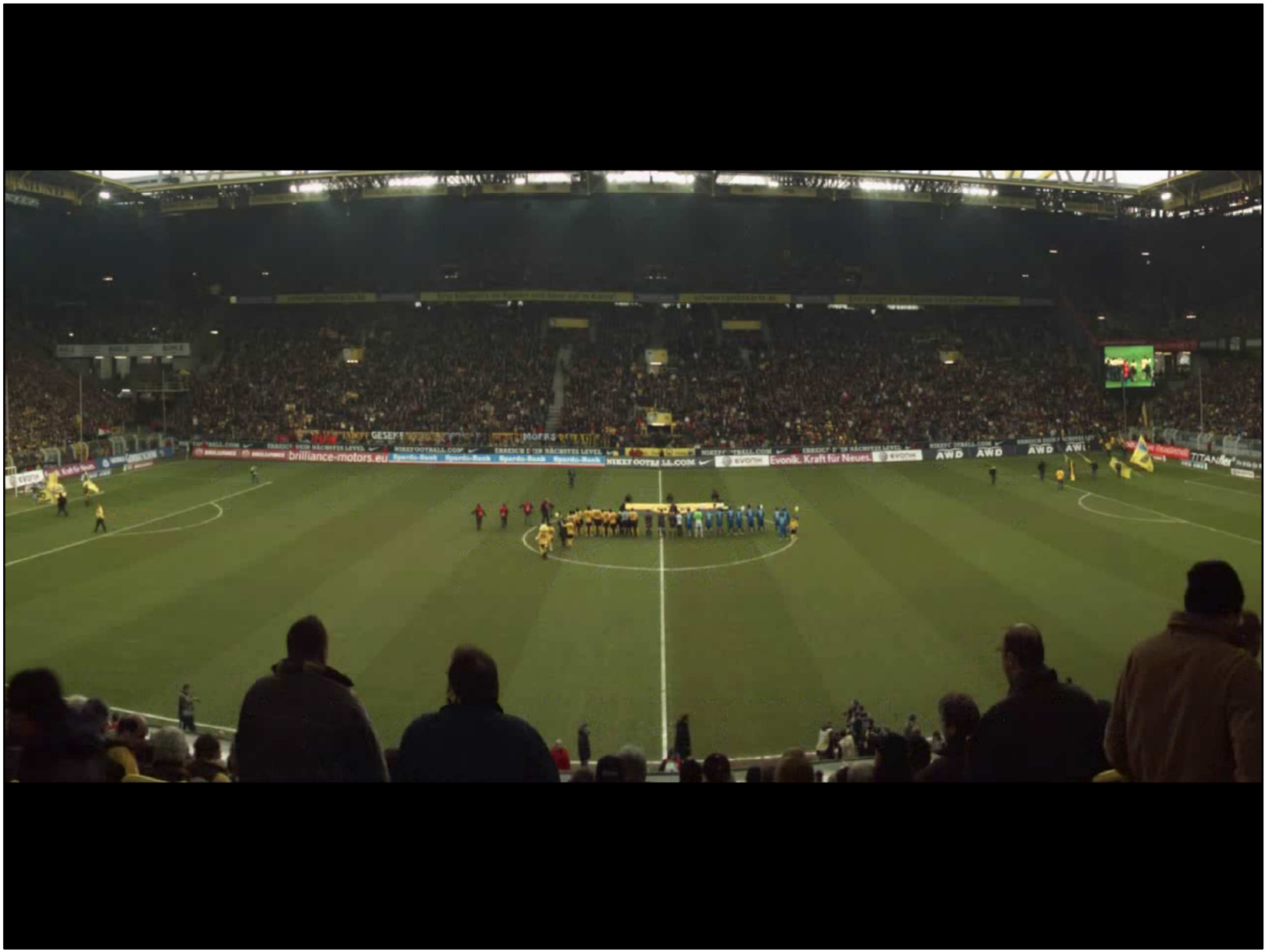

Recording of a VR navigation in a 180 degree panoramic : experience as being at the stadium

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TOWARDS NETWORK-FRIENDLY REPRESENTATIONS FOR FREE VIEWPOINT NAVIGATION

Jean-François MACQ

FTV Seminar – Sapporo - July 8, 2014

Bell Labs
Alcatel·Lucent

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INTERACTIVE PANORAMIC VIDEO = FREE *PAN-TILT-ZOOM TV*

180°

Panoramic video as a first step towards the navigation paradigm

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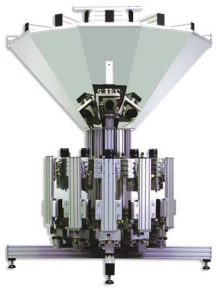
EU PROJECT FASCINATE (2010 – 2013) DEVELOPED A FORMAT-AGNOSTIC AUDIOVISUAL SYSTEM



Fraunhofer Heinrich-Hertz-Institut

Scene Acquisition

Content Analysis & Scripting

Adaptive Delivery

Terminal-side Formatting

THE UNIVERSITY OF SALFORD · BBC · ARRI · JOANNEUM RESEARCH · softeco sismat information technology · TNO innovation for life · Alcatel·Lucent · technicolor · UPC · INTERACTIVE INSTITUTE

FP7 FascinatE project developed a concept of « scene capturing ». Focus was on panoramic video (instead of full FTV), with requirements to maintain picture quality equivalent to broadcast.

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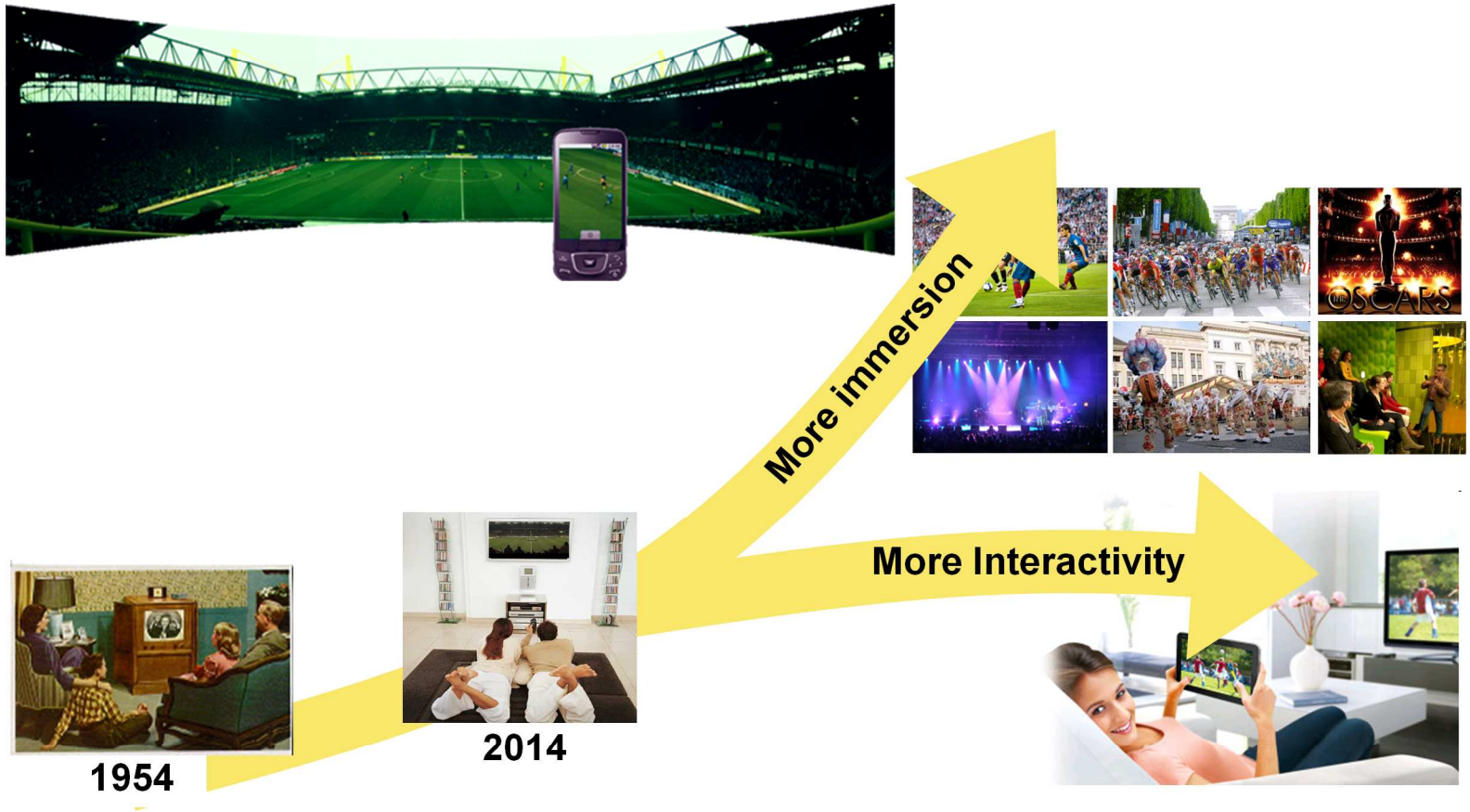
SCENE CAPTURING ENABLES IMMERSION & INTERACTIVITY



In the context of FTV, full three-dimensional scene acquisition can be used (a) to feed a super-multiview display (immersion), as well as (b) to enable a legacy device to navigate in the scene (interactivity)

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FTV AS THE ULTIMATE FORMAT AGNOSTIC MEDIA
THE NETWORK BECOMES MORE THAN A BITPIPE

Omnidirectional Video

Layered and Panoramic Video

NHK 8K Super High-Resolution & Integral Imaging

multi-camera

NOVEL MEDIA REPRESENTATION

Massive Scalability
Connectivity
Processing

MEDIA RETARGETING
to myriad of interfaces & devices

Holografika

Immersive VR

Multi-Screen Consumption

Increasing variability of input formats (with increasing source data rate) and broad range of display devices (in terms of network, computing resources as well as user experience) → the network as a universal gateway

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DATA RATE FOR FORMAT-AGNOSTIC PRODUCTION

Video

- Omnicam (6 HD cams)
- 4 HD Broadcast cams
- Static 3D Laser scan
- High Dynamic Range cam

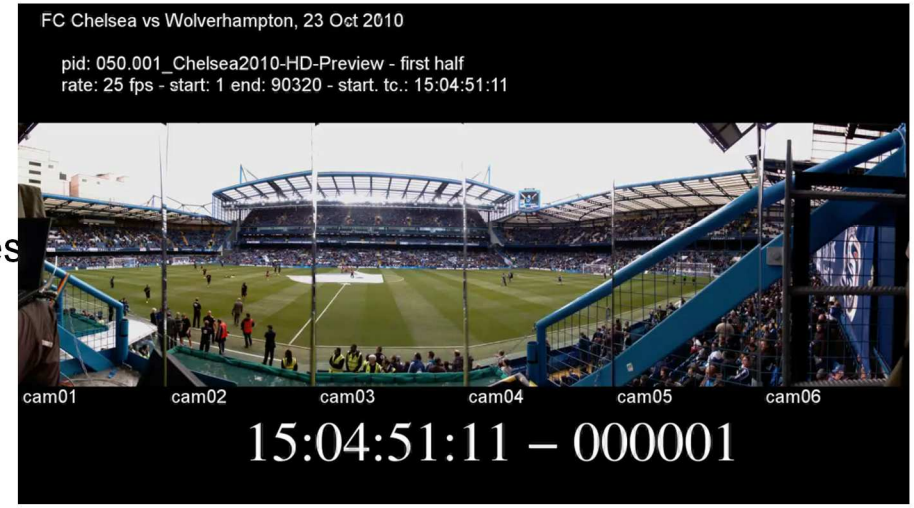
Audio

- 12 shotgun microphones
- Microphone array
- Surround Sound microphones
- Stereo microphones

8 min of content

1TB

16 Gbps



Fraunhofer
Heinrich-Hertz-Institut

Format-agnostic delivery obviously calls for high efficiency compression

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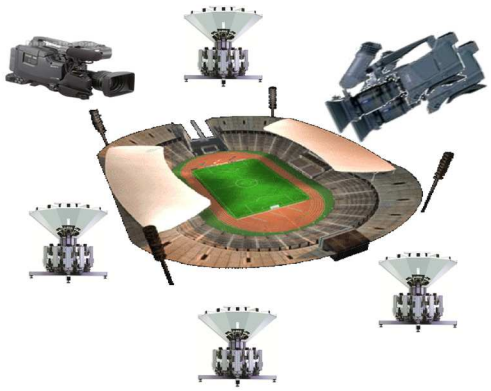
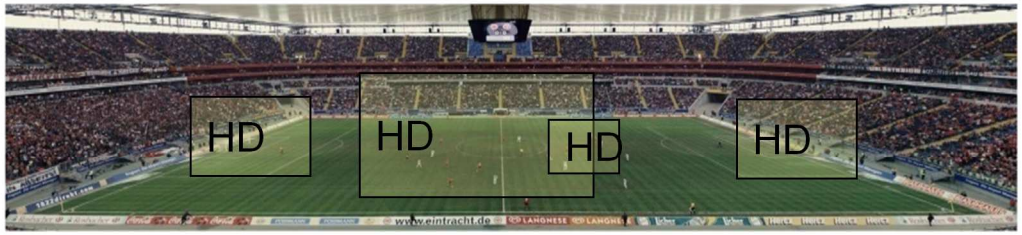
FROM PAN-TILT-ZOOM TO FREE VIEWPOINT NAVIGATION

- Multi 2D streams





Broad spectrum of representations ranging from 2D panoramic video till FTV. One initial step is a discrete combination of multiple 2D streams

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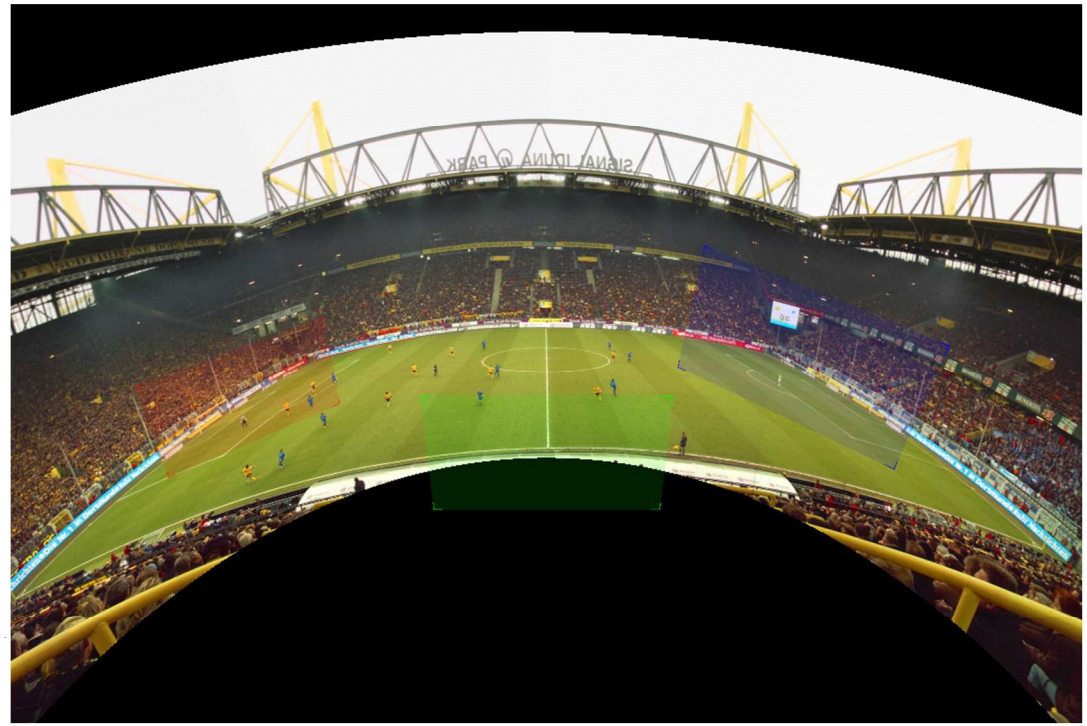
FROM PAN-TILT-ZOOM TO FREE VIEWPOINT NAVIGATION

- Multi 2D streams
- Cylindrical



technicolor

Depending on the type of panoramic camera, source 2D video may be seen as a texture to be embedded in the 3D visualization space, e.g. on a cylindrical surface.

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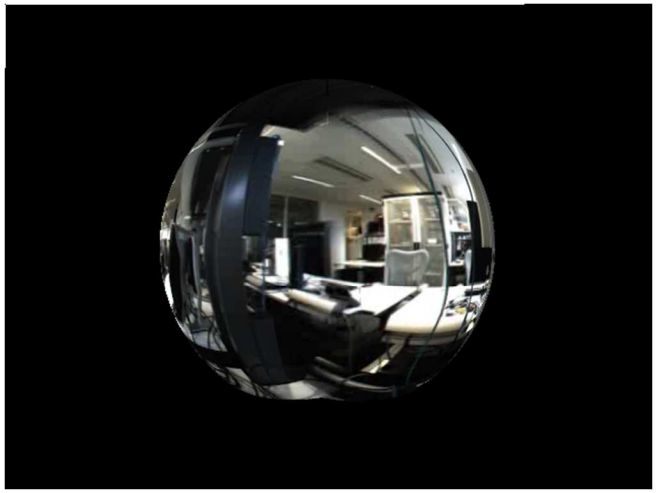
FROM PAN-TILT-ZOOM TO FREE VIEWPOINT NAVIGATION

- Multi 2D streams
- Cylindrical
- Spherical



Another example with full Omnidirectional camera, where video is to be mapped onto a sphere

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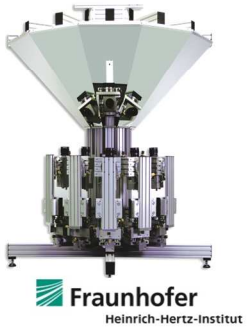
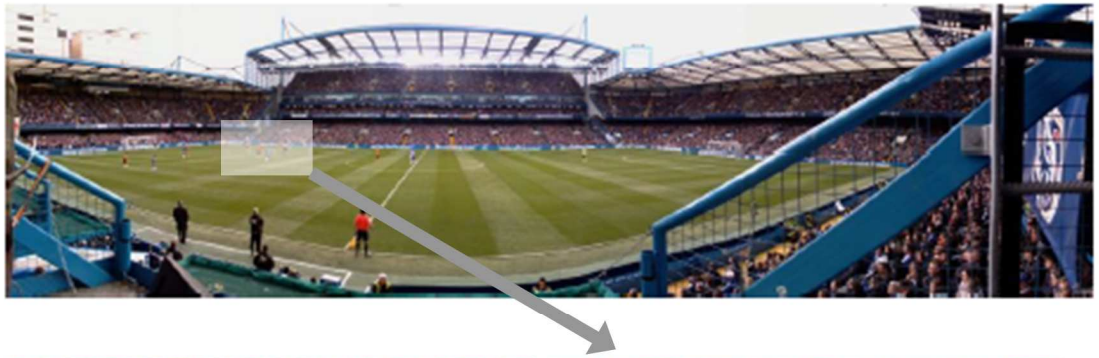
AN INTERMEDIATE STEP : POOR MAN'S FTV





To Handle :

- Disparities
- Motion blur
- Color differences

FascinatE explored the possibility to seamlessly transition from a (digitally) zoomed-in view on the panorama to a corresponding view captured from broadcast cams. Bottom picture illustrates the disparity issues one has to solve.

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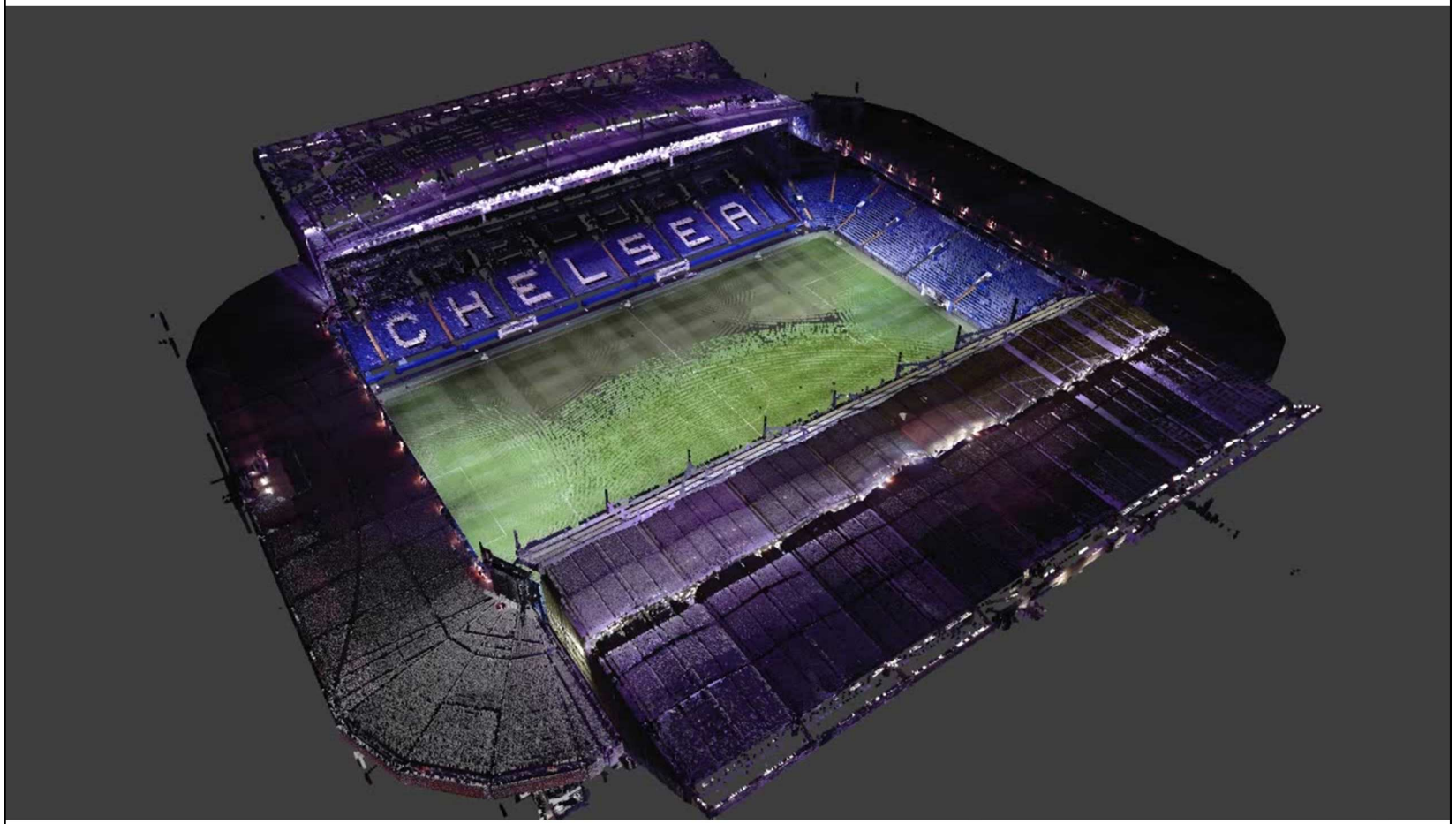
STATIC 3D SCAN



A following step? Dense 3D point cloud of the venue, to be used for augmenting the navigation space, and to facilitate registration of acquisition devices.

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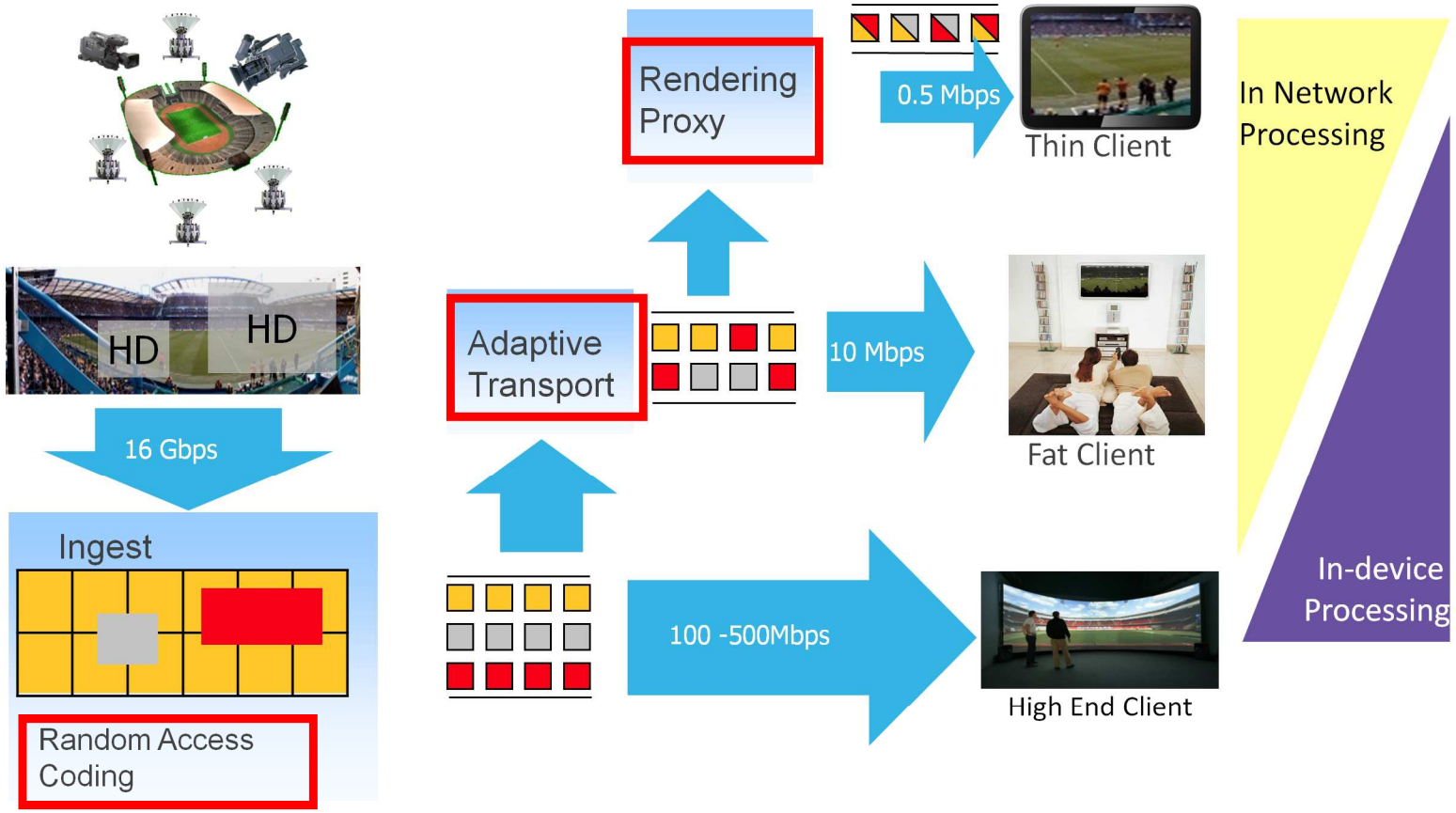
GENERIC ARCHITECTURE



Generic architecture can support any scene navigation system (from panoramic to FTV). Support of very high end display (able to process the entire source data) as well as lower-capabilities devices (requiring the network to actively adapt and/or process the data streams)

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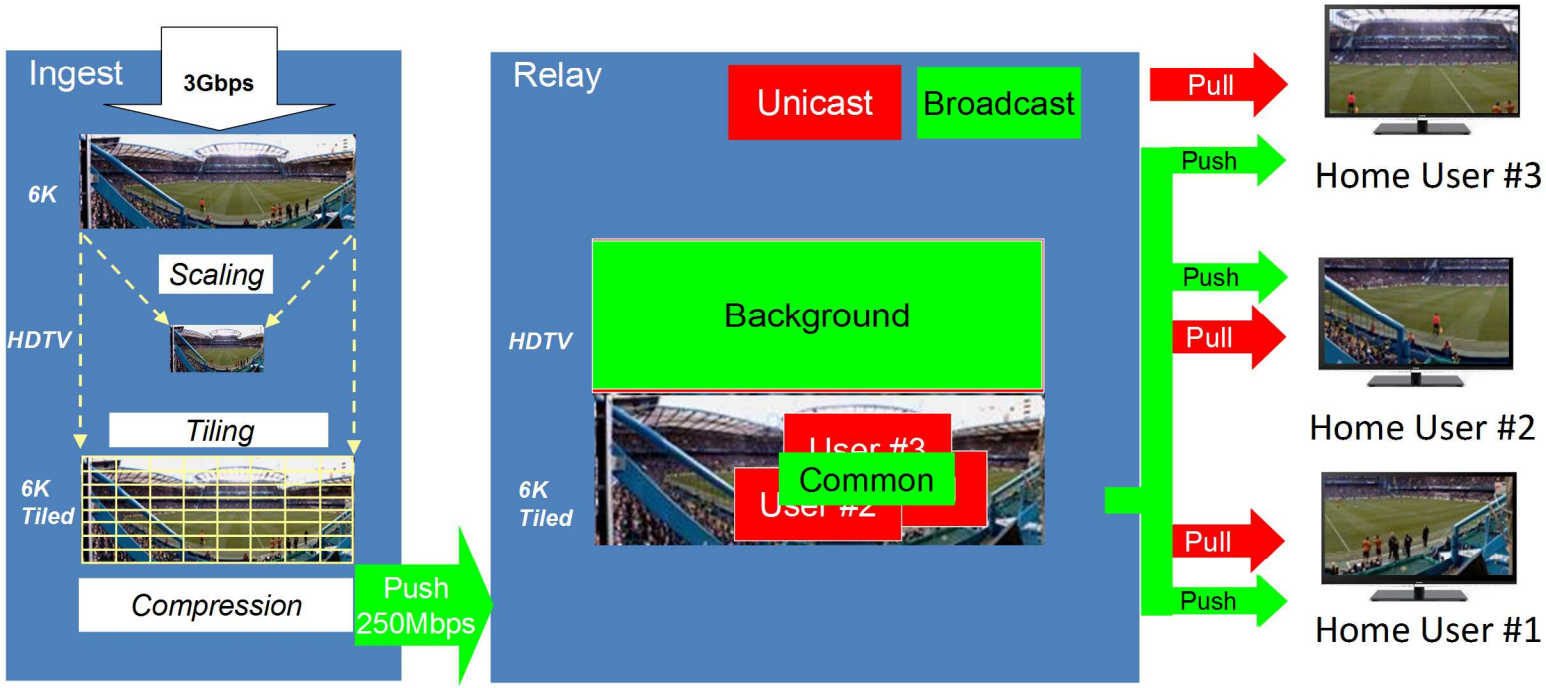
SPATIAL SEGMENTATION FOR ADAPTIVE DELIVERY OF PANORAMIC VIDEO

Tiled-based compression



The delivery system developed in FascinatE relies on a segmentation of input data. Clients can therefore selectively access the portions of the scene they need (with the possibility of dynamically combining unicast and broadcast delivery)

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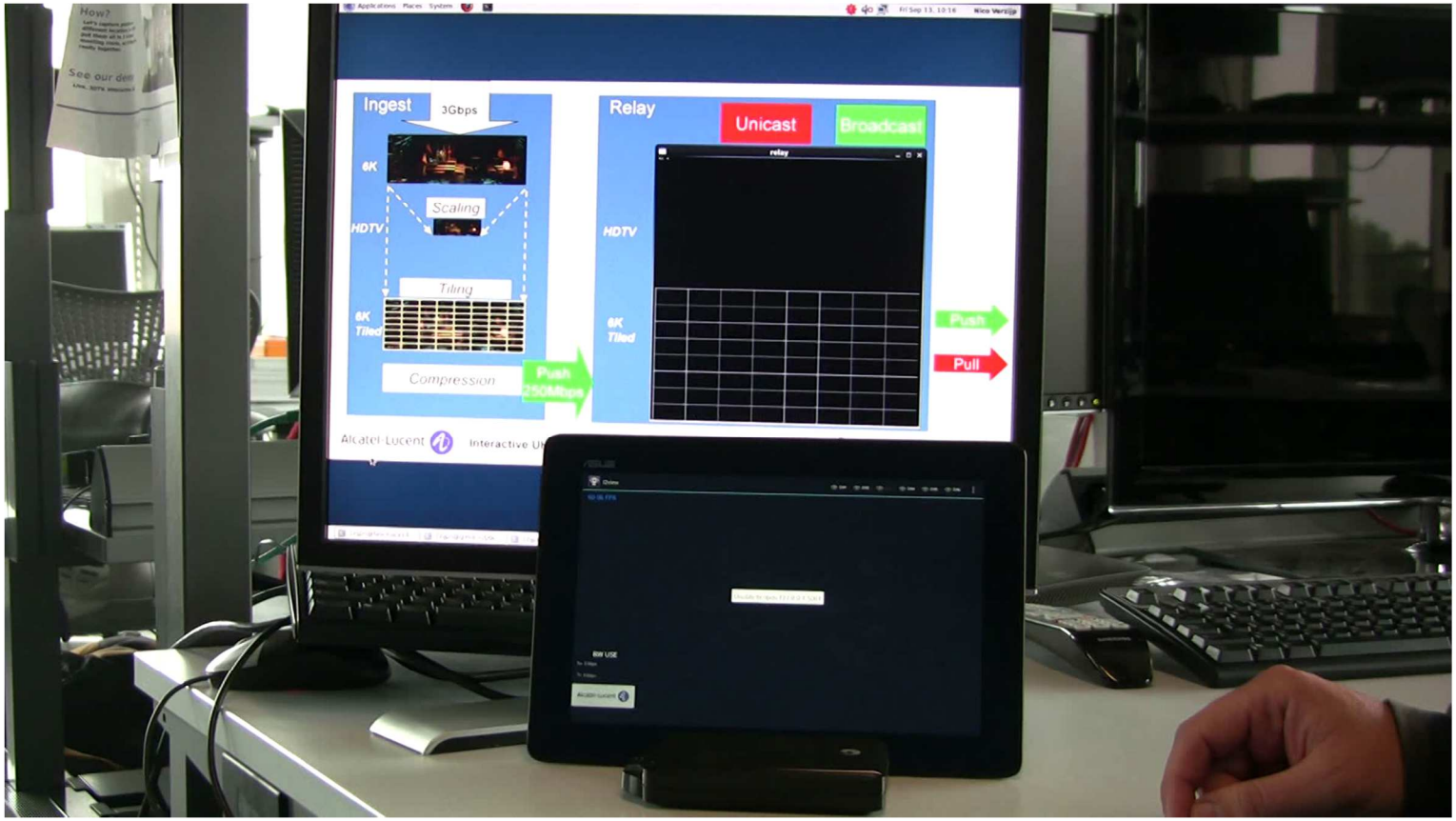
SPATIAL SEGMENTATION FOR ADAPTIVE DELIVERY OF PANORAMIC VIDEO



Demo movie

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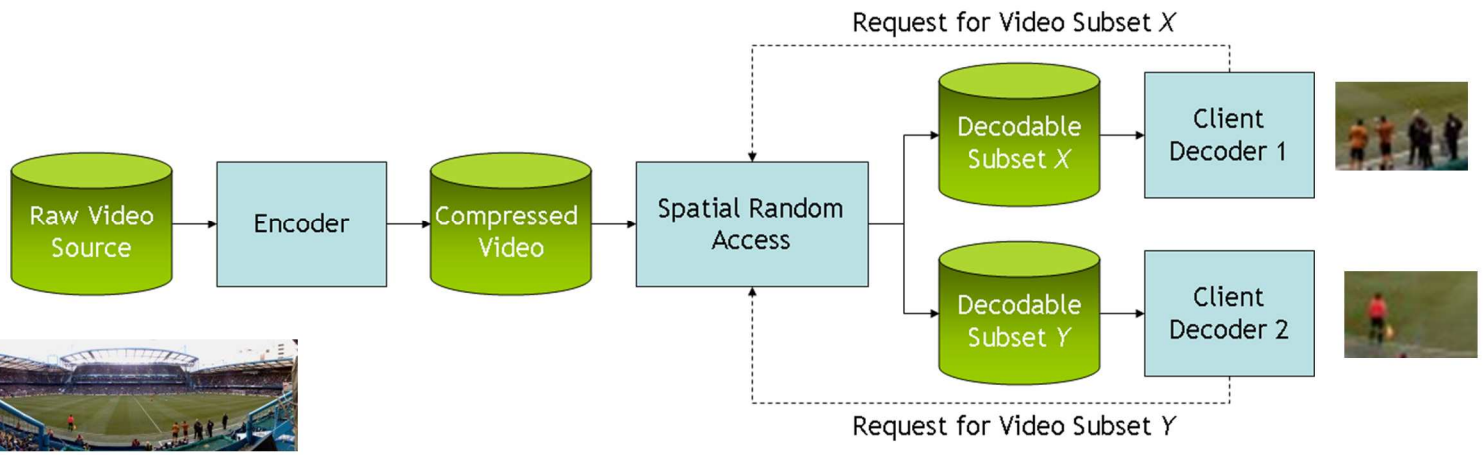
HOW FINE SHOULD THE TILING BE?
A.K.A. SPATIAL RANDOM ACCESS (S-RA)



2 Extremes

- Monolithic coding : great compression – no S-RA
- Keep pixel accessible : great S-RA – no compression

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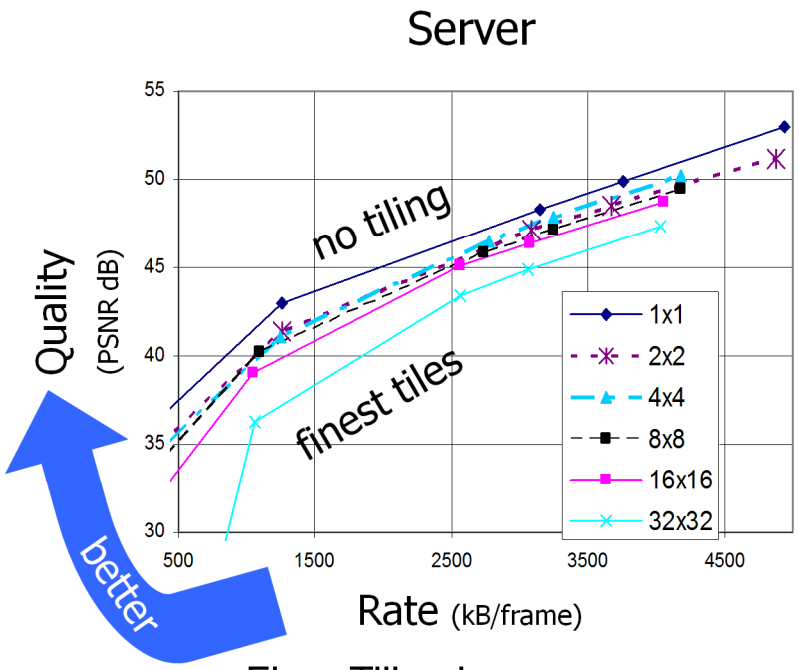
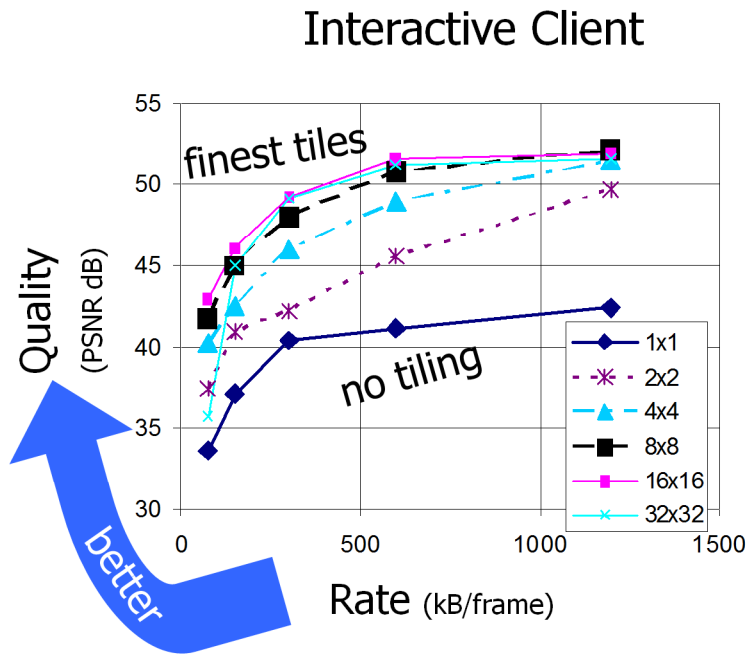
TRADE-OFF ON SPATIAL RANDOM ACCESS



Finer Tiling increases server Total output bitrate



Finer Tiling decreases each client's input bitrate

P. Rondao Alface, J.-F. Macq, N. Verzijp, "Interactive Omni-directional Video Delivery: a Bandwidth-Effective Approach", *Bell Labs Technical Journal*, vol. 16(4), pp. 135-147, Wiley, 2012.

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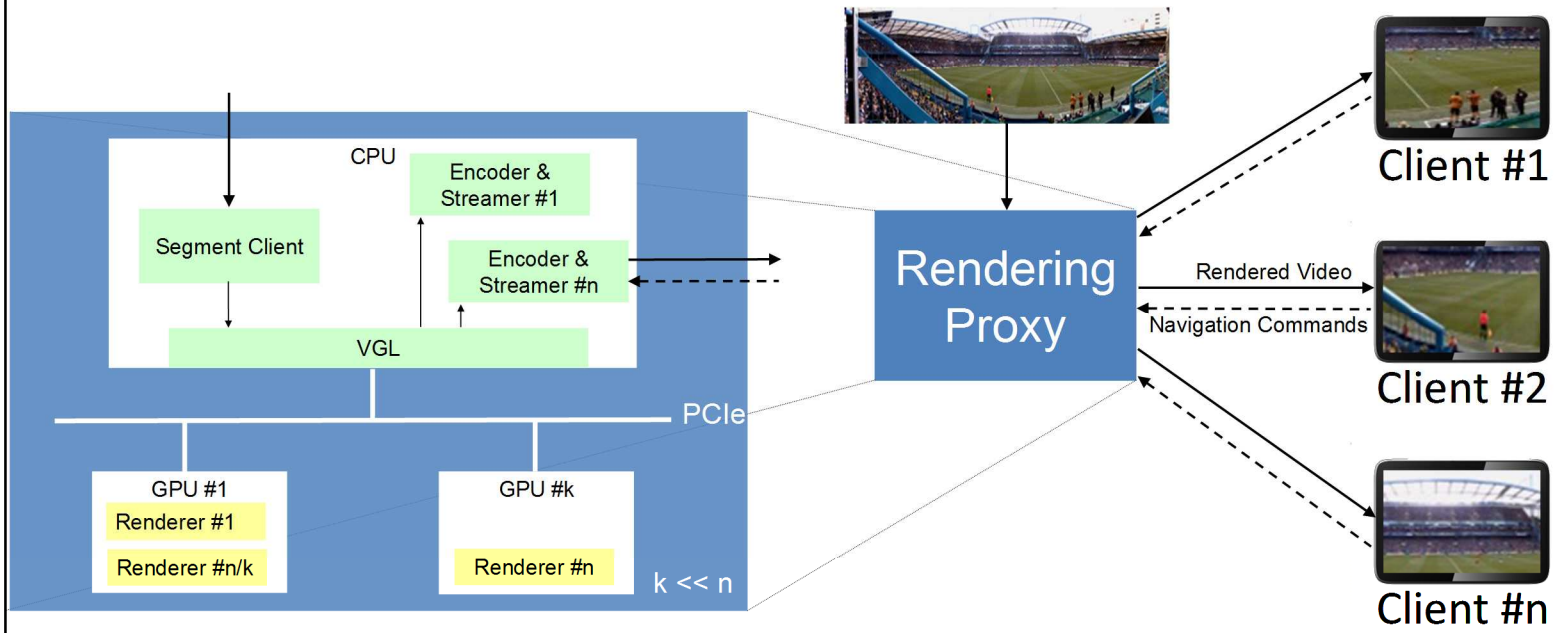
PERFECT RANDOM ACCESS
IN-NETWORK RENDERING

Perfect Random Access

Network-side complexity



Network nodes supports up to **40 CLIENTS @ 720p** per GPU

This second solution allows perfect random access by performing on-the-fly rendering and compression on the network side. The processing technology we developped can scale using commoditized hardware.

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IN-NETWORK RENDERING OF LIVE 6K PANORAMIC VIDEO

« PERCEIVED» LATENCY

0 → ~0.5 sec

SHAPED BY SERVER PING TIME

Live Demo

MediaCity UK

Manchester

May 2013

Demo movie, offline replica of the live demo showcasing the entire FascinatE system (live acquisition → delivery → in-network rendering → interactive tablets to local and remote audience).

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REQUIREMENTS

COMPRESSIBILITY

COMPLEXITY

RANDOM ACCESS

LATENCY

USABILITY

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LATENCY !

Latency currently reached in prototypes is ok for interactive TV applications.

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LATENCY !

Living with Lag

But is probably not yet OK for other applications, in particular in Virtual/Mixed Reality (e.g. remote surgery, control, …)
See http://www.youtube.com/watch?v=_fNp37zFn9Q

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REQUIREMENTS

COMPRESSIBILITY

WHAT EFFICIENT REPRESENTATION FOR FTV ?

COMPLEXITY

RANDOM ACCESS

LATENCY

USABILITY

Moving towards true FTV, compressibility is one the key requirements to be looked at

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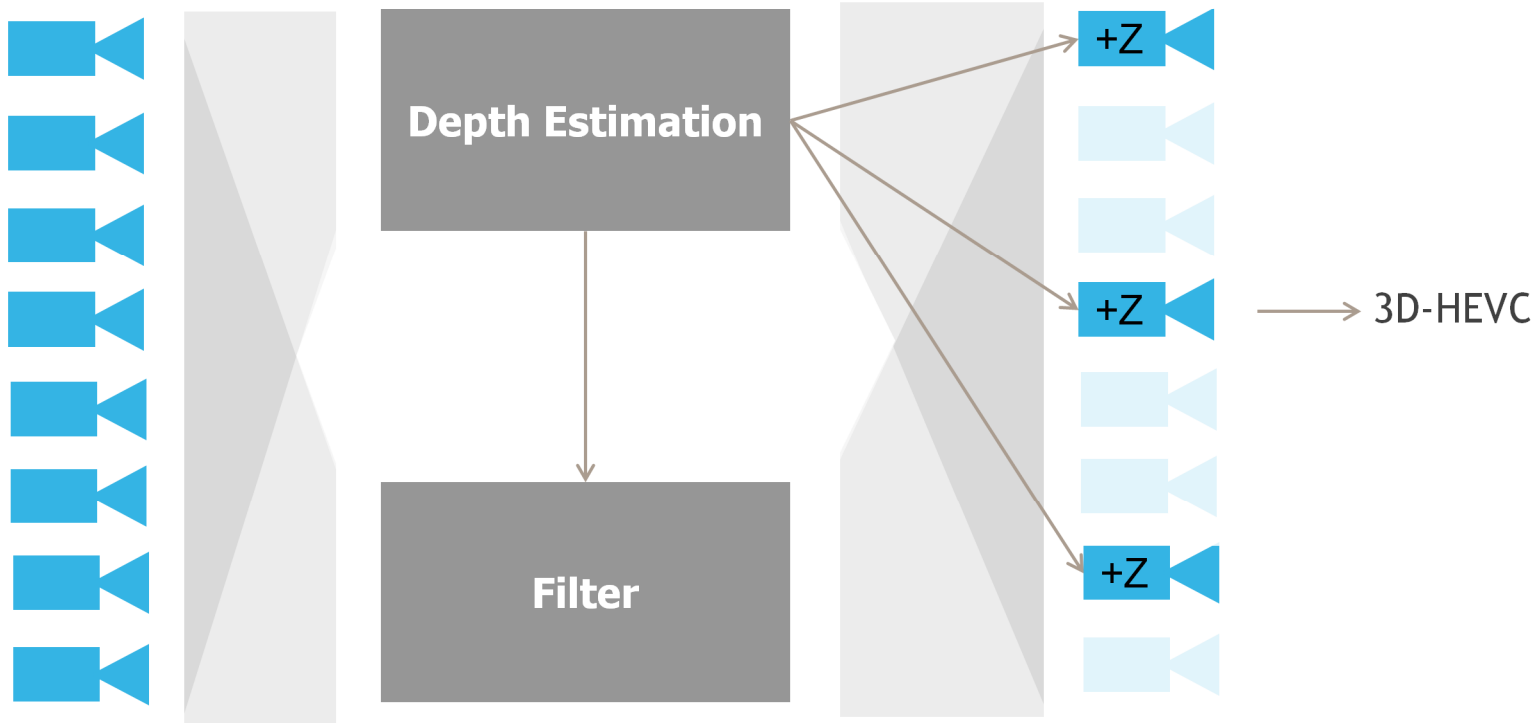
WHAT EFFICIENT REPRESENTATION FOR FTV?
1. KEEP INPUT VIEWS AS MAIN MODALITY, BUT FILTER



Trade-off View Density against Geometry/Structure side info

Current technologies(such as 3D-HEVC) have been primarily designed for few cameras and narrow-baseline set-up. For denser and/or wider baseline set-up, key question is how many views can be skimmed from the transported set

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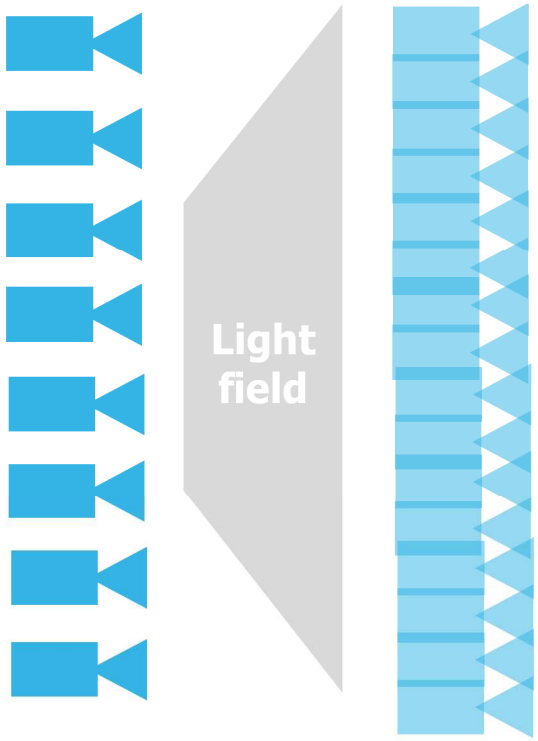
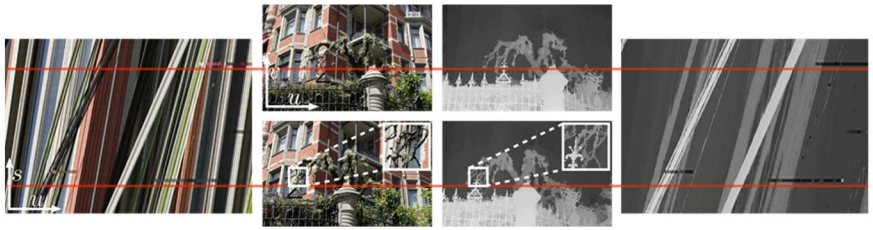
WHAT EFFICIENT REPRESENTATION FOR FTV?
2. « IBR » LIFTING TO LIGHTFIELD



What Compression?

What Random Access?

Client-side Scene Reconstruction



High Quality of view synthesis (Kim et al., SIGGRAPH 2013)

Instead of keeping the captured views as the main « modality », alternative approaches aim at a first creating a continuous model of set of scene views. Driving motivation is the quality of reconstruction (see recent examples using ligthtfield)

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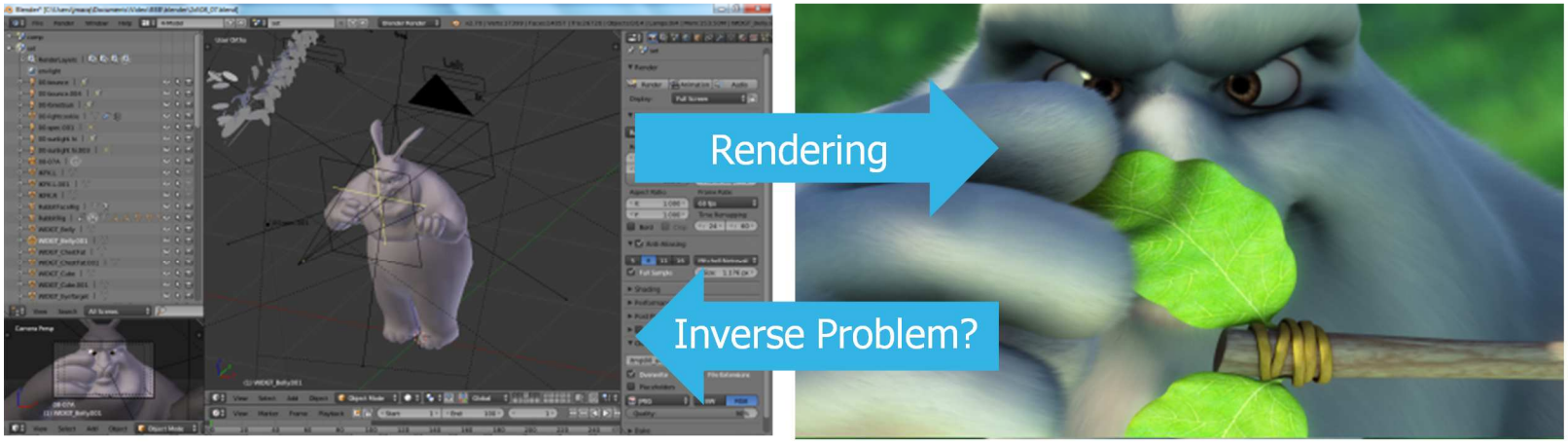
WHAT EFFICIENT REPRESENTATION FOR FTV?
3. « MODEL-BASED » LIFTING

Promising Compression ? vs. Complexity at encoder & decoder



Blender source models
→ Complete scene knowledge
@ ~ 4 Mbps

2D rendered video - 4K - 60fps
→ HQ Lossy compression ~ 10Mbps
→ to be scaled for stereo, multiview, …

Representations could also be lifted in radically different ways. Model-based approaches can potentially bring very poweful compression. A sketch argument is the inherent compression offered by the source models of CG animations.

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REQUIREMENTS

COMPRESSIBILITY

COMPLEXITY

RANDOM ACCESS

LATENCY

USABILITY ? *… User interfaces for FTV*

A last key requirement for the deployment of FTV applications is the development of natural environments and interfaces to navigate into the content.

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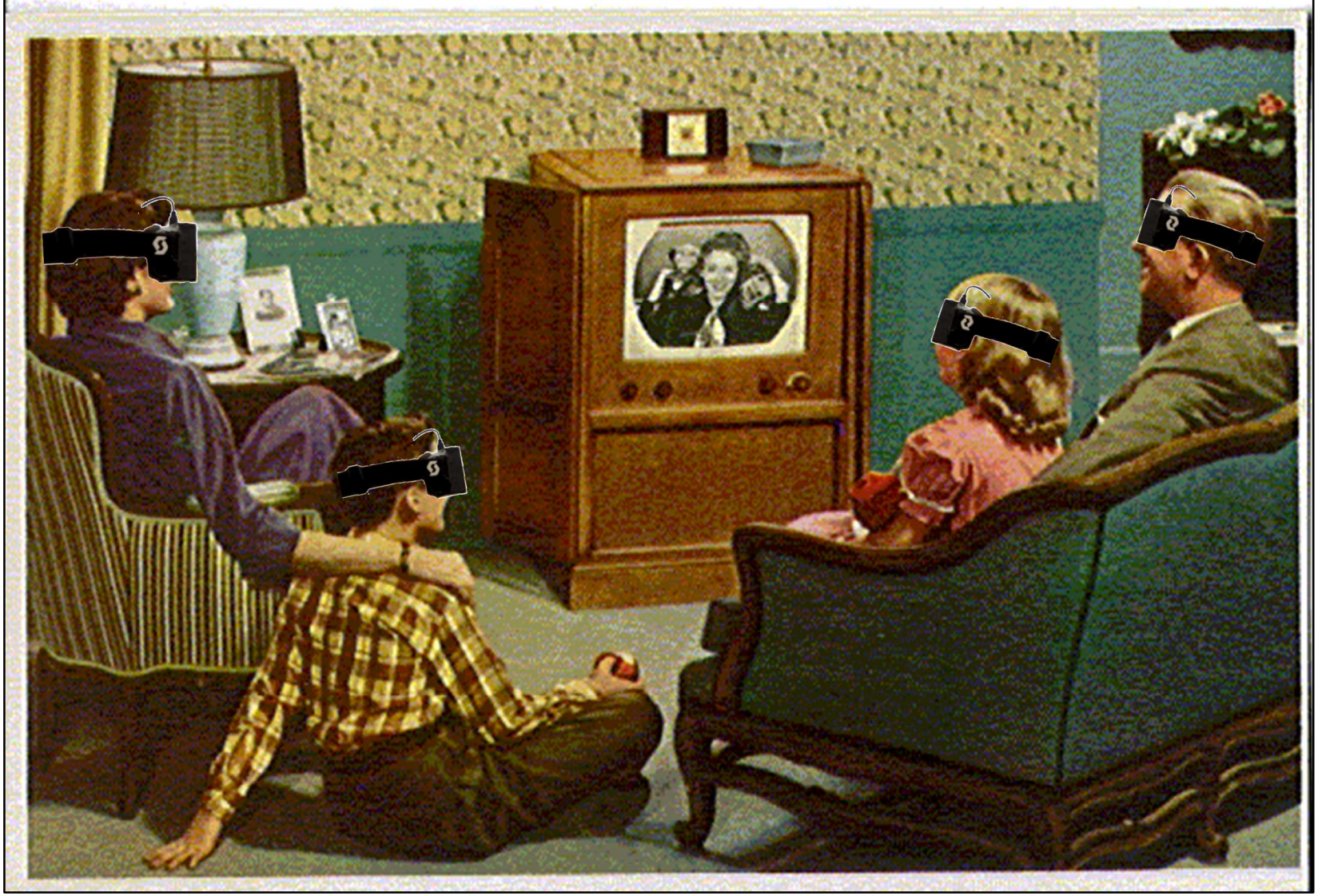
FTV A SHARED EXPERIENCE ?



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FLY-THROUGH ?

How to design natural and lightweight interfaces for free viewpoint navigation?

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