
TECHNOLOGY
FUTURES INC.
Your Bridge to the Future

TFI 2023 Sponsors

costquest.com

kroll.com

ryan.com

THANK YOU!

TECHNOLOGY FUTURES INC.

Banking on Broadband: New Visualization and Communication Technologies

Lawrence Vanston, Ph.D.

President, Technology Futures, Inc.

Executive Director, TFI Projects & Art 84

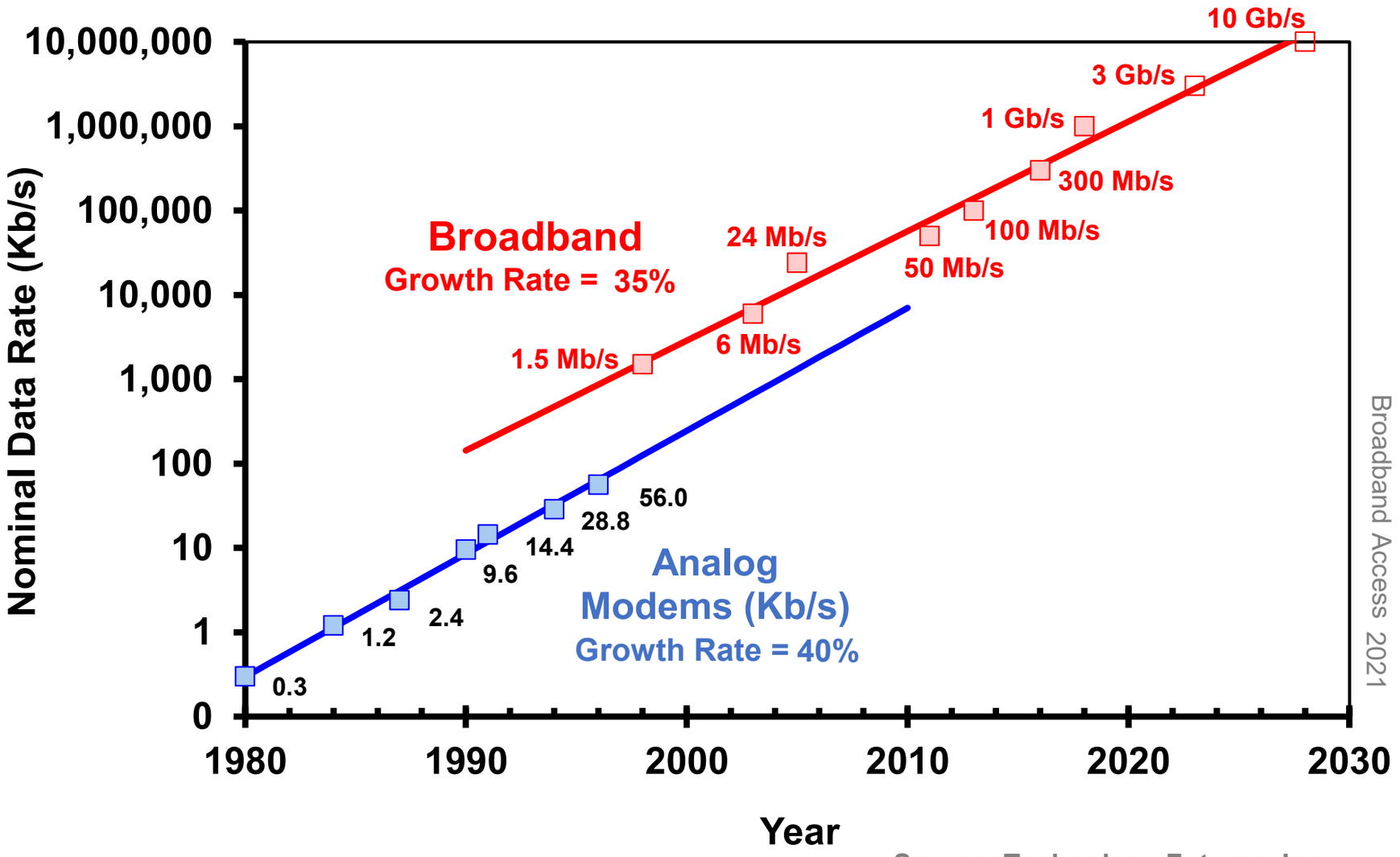
lvanston@tfi.com

TFI Technology Conference 2023

January 26-27, 2023
Austin, Texas
and Online

TECHNOLOGY FUTURES INC.

Broadband Performance Milestones



Source: Technology Futures, Inc.

TECHNOLOGY FUTURES INC.

How Long Will Broadband Speeds Increase?

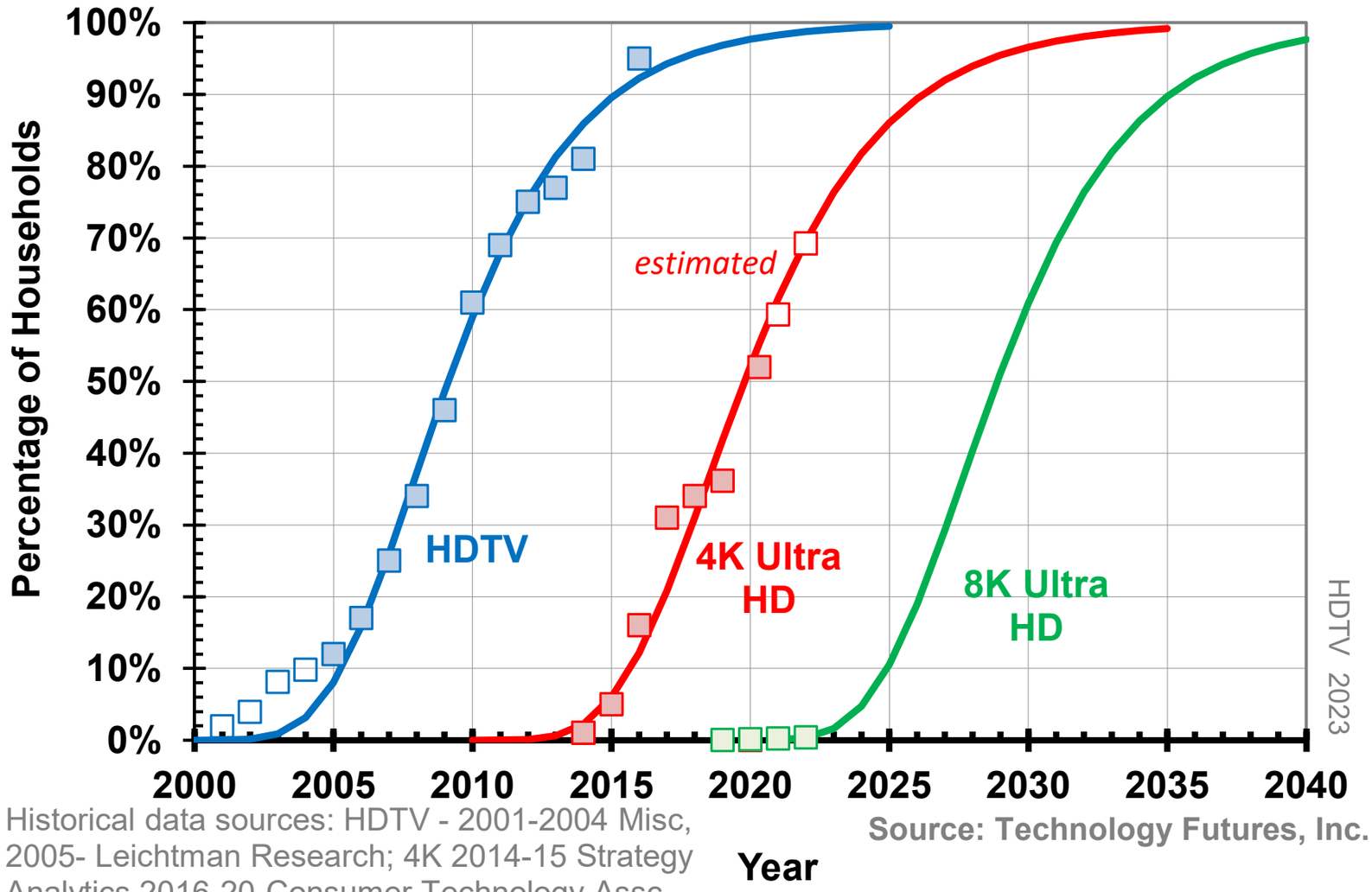
Key Technology Forecasting Principle:

- Performance improvement will continue as long as it's:
  - Technically feasible AND
  - Useful

- The rate may change if the technology approach changes.

TECHNOLOGY FUTURES INC.

Ultra HD Households (4K and 8K) - 2023 TFI Forecast



Historical data sources: HDTV - 2001-2004 Misc, 2005- Leichtman Research; 4K 2014-15 Strategy Analytics,2016-20 Consumer Technology Assc
8K - 2019-20 Strategic Analytics, 2021-23 Trendforce

Source: Technology Futures, Inc.

Typical Streaming Data Rates

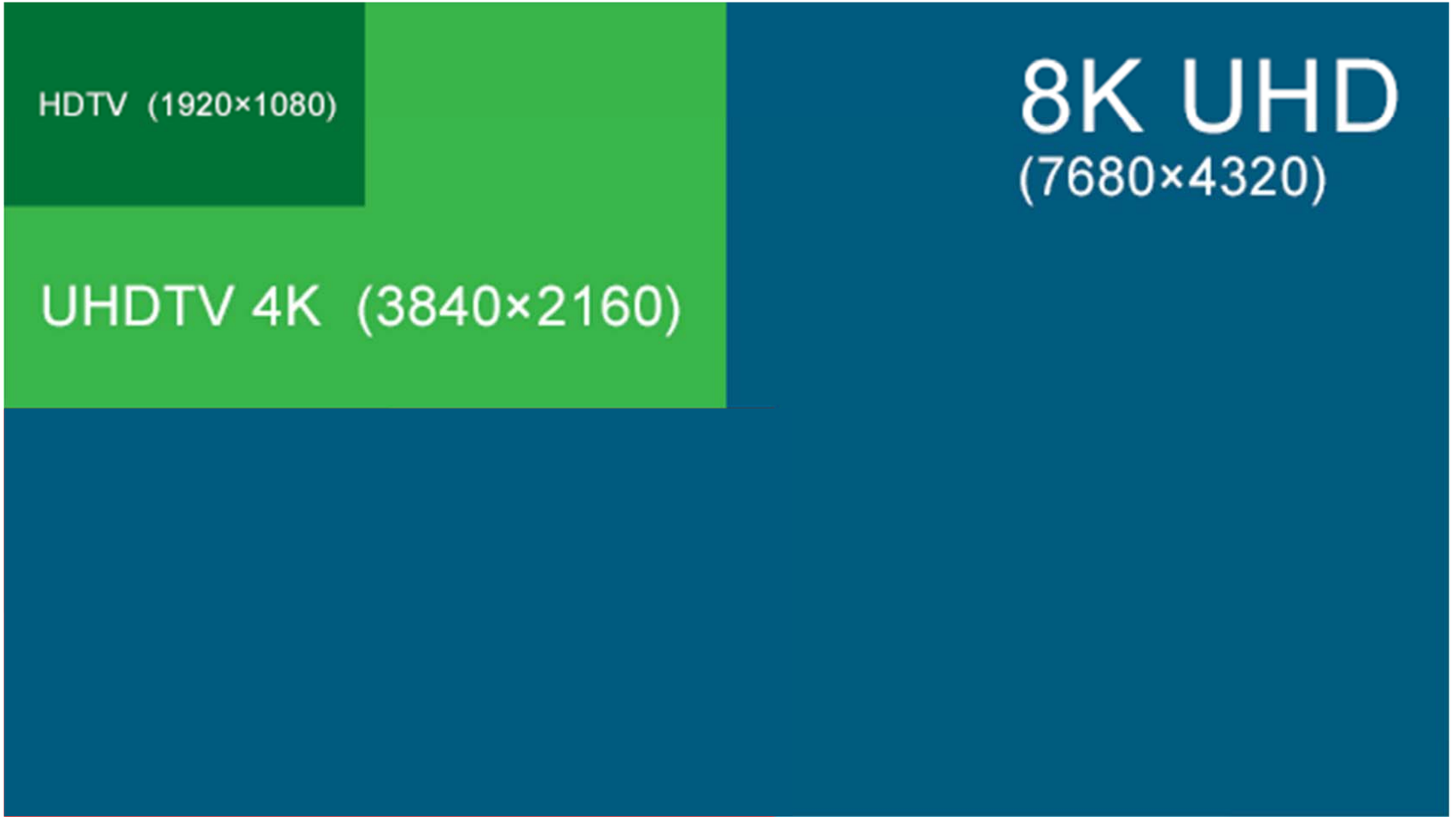
Std TV = ~ 2 Mb/s

HDTV = ~ 4 Mb/s

4K UHD = ~ 18 Mb/s

8K UHD = ~ 60 Mb/s

TECHNOLOGY FUTURES INC.



TECHNOLOGY FUTURES INC.

Video Data Rates

	Horz Pixels	x	Vert Pixels	x	Bits/ Pixel	x	Frame s/sec	x	Depth	x	Lens	=	Raw bits/sec	Raw Gb/s	Compressed Comp	Compressed Gb/s	Compressed Mb/s
HDTV (General Video)	1920		1080		24		30		1		1		1,492,992,000	1.5	50	0.03	30
4K TV (General Video)	3840		2160		24		30		1		1		5,971,968,000	6.0	50	0.12	119
8K TV (General Video)	7680		4320		24		30		1		1		23,887,872,000	24	50	0.48	478
HDTV (Netflix)	1920		1080		24		30		1		1		1,492,992,000	1.5	400	0.00	4
4K TV (Netflix)	3840		2160		24		30		1		1		5,971,968,000	6.0	400	0.01	15
8K TV (Netflix, proj)	7680		4320		24		30		1		1		23,887,872,000	24	400	0.06	60

TECHNOLOGY FUTURES INC.

New Visualization & Communication Technologies

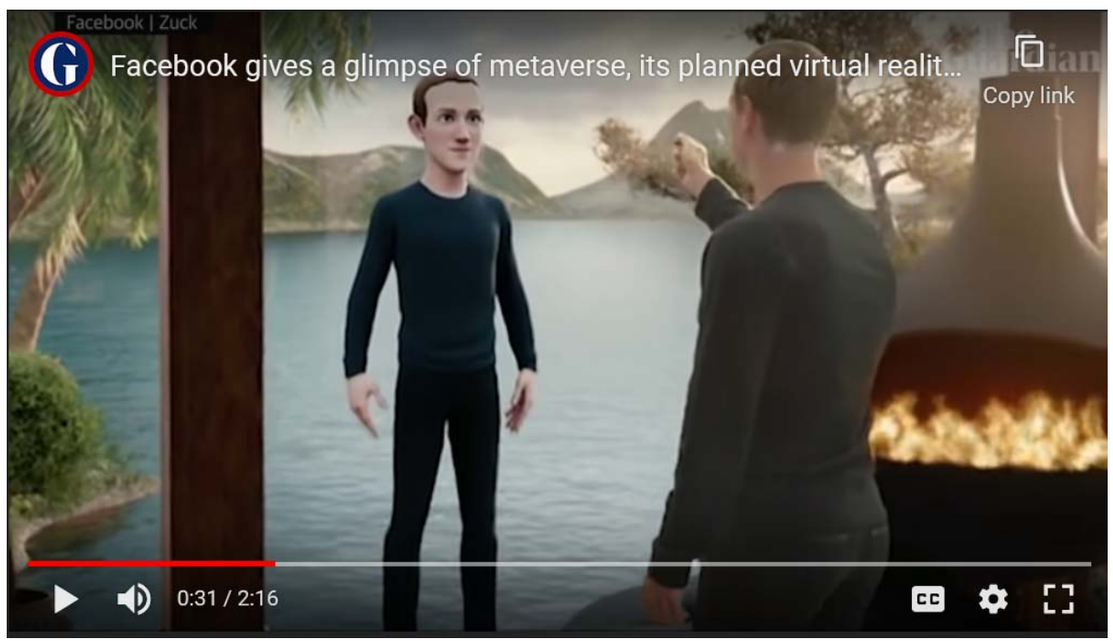
- Virtual Reality (VR)
- Augmented Reality (AR)
- Immersion Rooms
- Holographic Glasses
- Holographic Displays
- Holographic Immersion Rooms

TECHNOLOGY FUTURES INC.

Virtual Reality (VR)

Digital environment that replaces the user's real world.

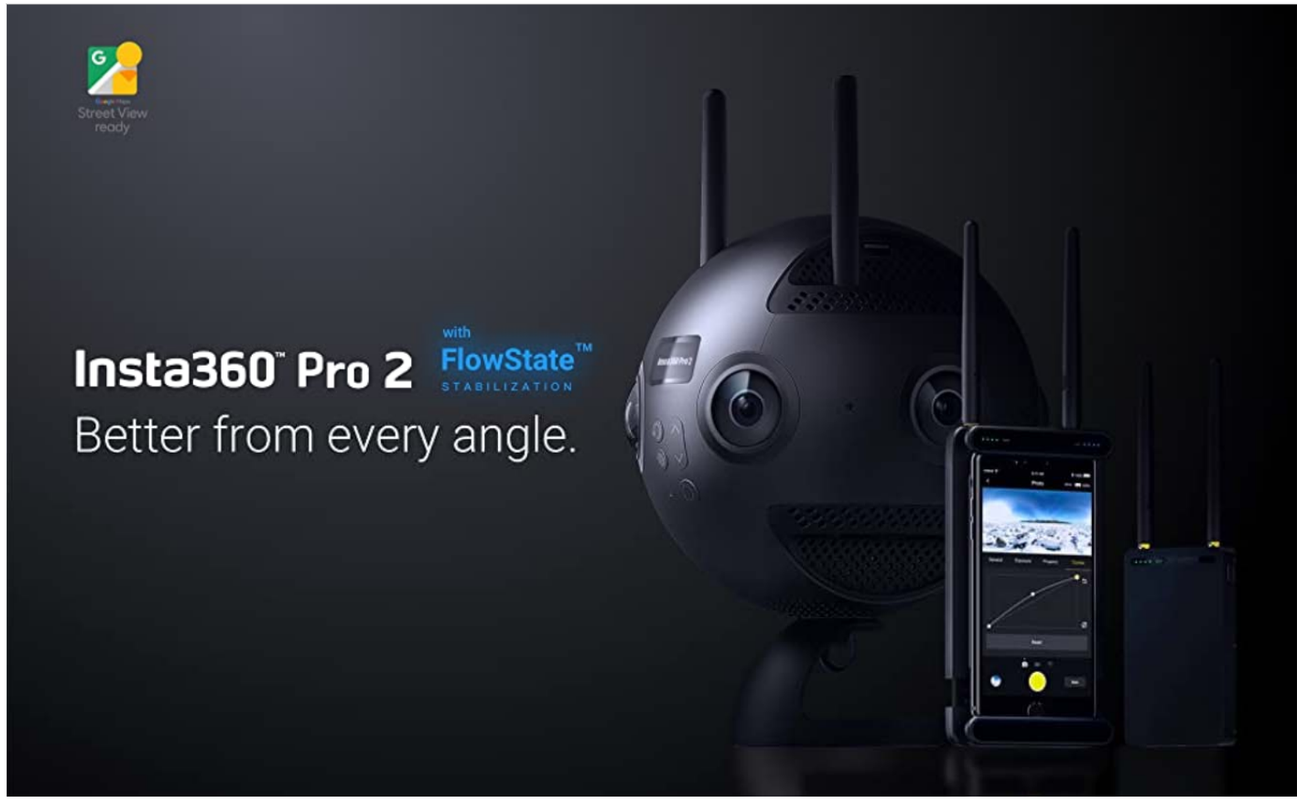
- Metaverse - "… a set of virtual spaces where you can create and explore with other people who aren't in the same physical space as you." - Facebook



https://www.youtube.com/watch?v=SAL2JZxpoGY

https://youtu.be/HHa9gRFWlvw

Virtual Reality Cameras



Video

Video Format: MP4

Real-time Stitching:

3840*3840@30fps (3D)

3840*1920@30fps (2D)

Post-processing Stitching:

7680*3840@30fps HDR (8K 2D)

7680*7680@30fps (8K 3D)

7680*3840@60fps (8K 2D)

6400*6400@60fps (6K 2D/3D)

General

Lenses: 200° 6 x F2.4 fisheye lenses

Bitrate per lens: Up to 120Mbps

TECHNOLOGY FUTURES INC.

VR Camera Data Rates

	Horz Pixels	x	Vert Pixels	x	Bits/ Pixel	x	Frame s/sec	x	Depth	x	Lens	=	Raw bits/sec	Raw Gb/s	Compressed Comp	Compressed Gb/s	Compressed Mb/s
4K (3D VR) per lens	3840		3840		24		60		1		1		21,233,664,000	21	50	0.42	425
8K (3D VR) per lens	7680		7680		24		30		1		1		42,467,328,000	42.5	50	0.85	849
4K (3D VR)	3840		3840		24		60		1		6		127,401,984,000	127	50	2.55	2,548
8K (3D VR)	7680		7680		24		30		1		6		254,803,968,000	254.8	50	5.10	5,096

TECHNOLOGY FUTURES INC.

VR is on the Edge: How to Deliver 360° Videos in Mobile Networks

Simone Mangiante
Vodafone Group R&D
Newbury, UK
simone.mangiante@vodafone.com

Guenter Klas
Vodafone Group R&D
Newbury, UK
guenter.klas@vodafone.com

Amit Navon
Huawei, Network Technology Lab
Israel
amit.navon@huawei.com

Zhuang GuanHua
Huawei, Network Technology Lab
Nanjing, China
zhuangguanhua@huawei.com

Ju Ran
Huawei, Network Technology Lab
Nanjing, China
juran@huawei.com

Marco Dias Silva
Vodafone Group R&D
Newbury, UK
marco.silva1@vodafone.com

Table 1: VR network requirements (bandwidth and latency)

	VR resolution	Equivalent TV res.	Bandwidth	Latency
Early stage VR (current)	1K*1K@visual field 2D_30fps_8bit_4K	240P	25 Mbps	40 ms
Entry level VR	2K*2K@visual field 2D_30fps_8bit_8K	SD	100 Mbps	30 ms
Advanced VR	4K*4K@visual field 2D_60fps_10bit_12K	HD	400 Mbps	20 ms
Extreme VR	8K*8K@visual field 3D_120fps_12bit_24K	4K	1 Gbps (smooth play) 2.35 Gbps (interactive)	10 ms

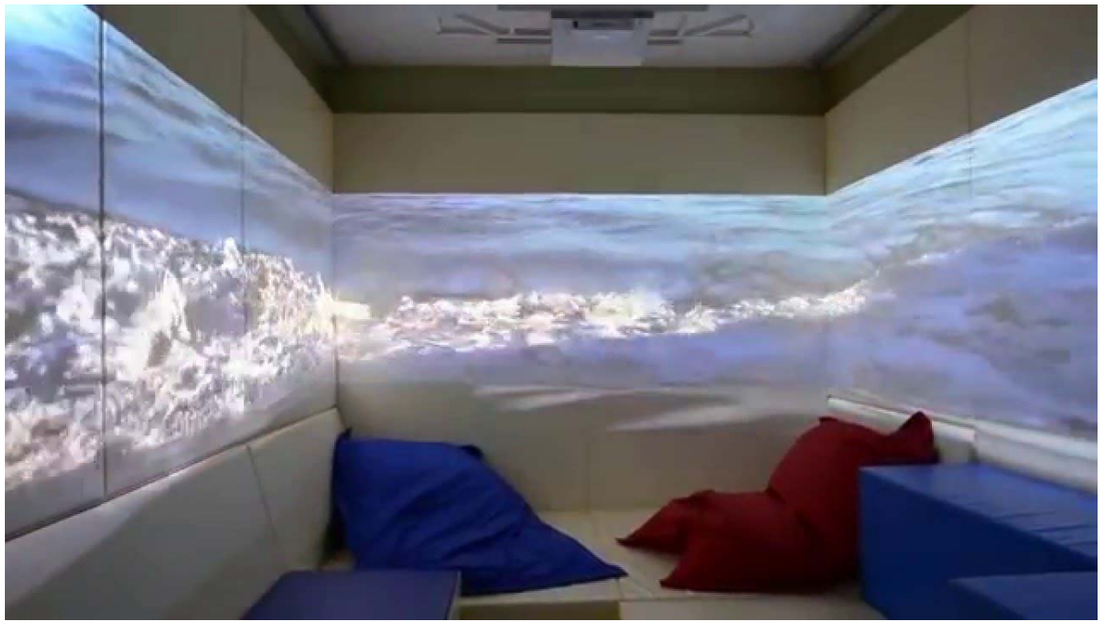
Augmented Reality (AR)

Overlays digitally created content onto the real-world environment.

https://www.zdnet.com/article/augmented-reality-invades-the-conference-room/

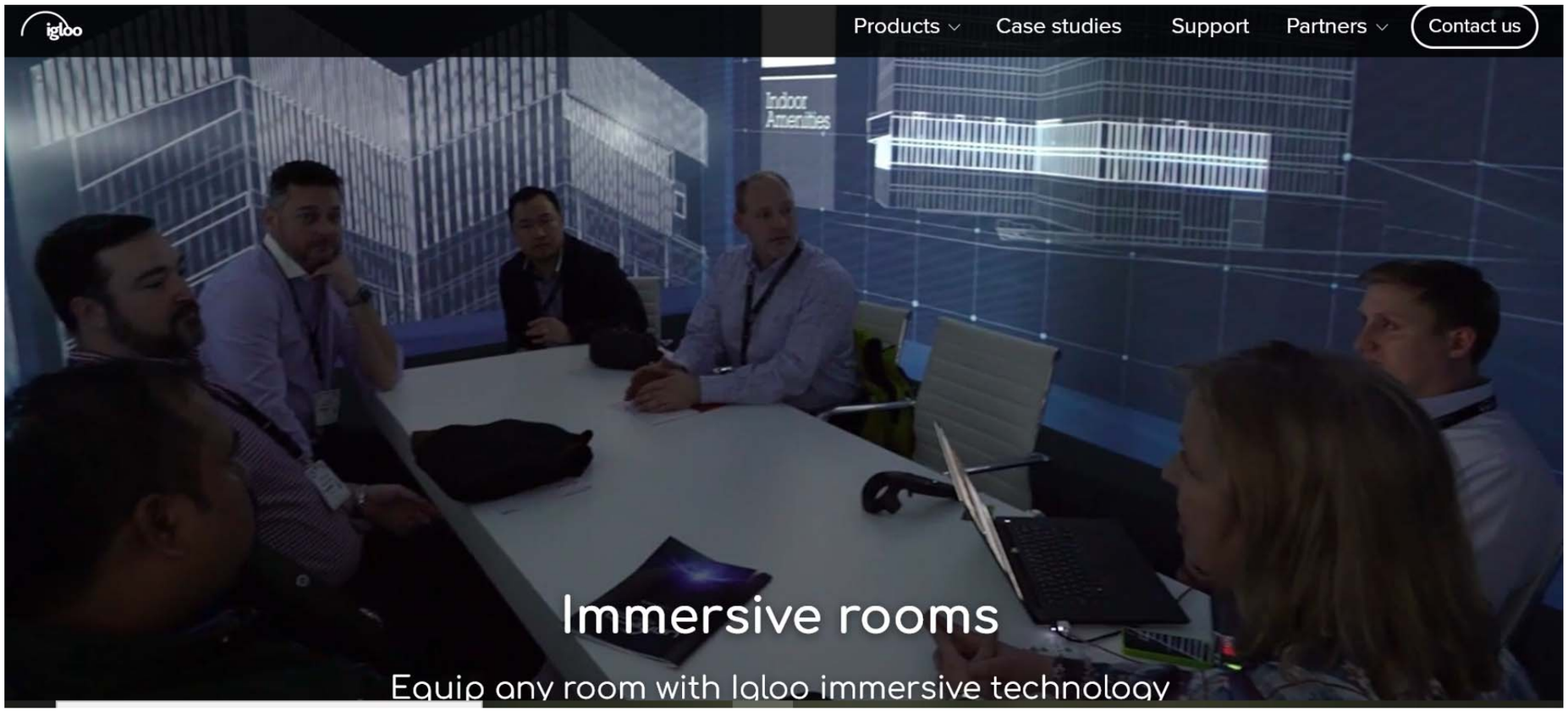
TECHNOLOGY FUTURES INC.

Immersion Rooms



TECHNOLOGY FUTURES INC.

Immersion Conference Rooms



https://www.igloovision.com/products/technology/immersive-workspaces-and-rooms

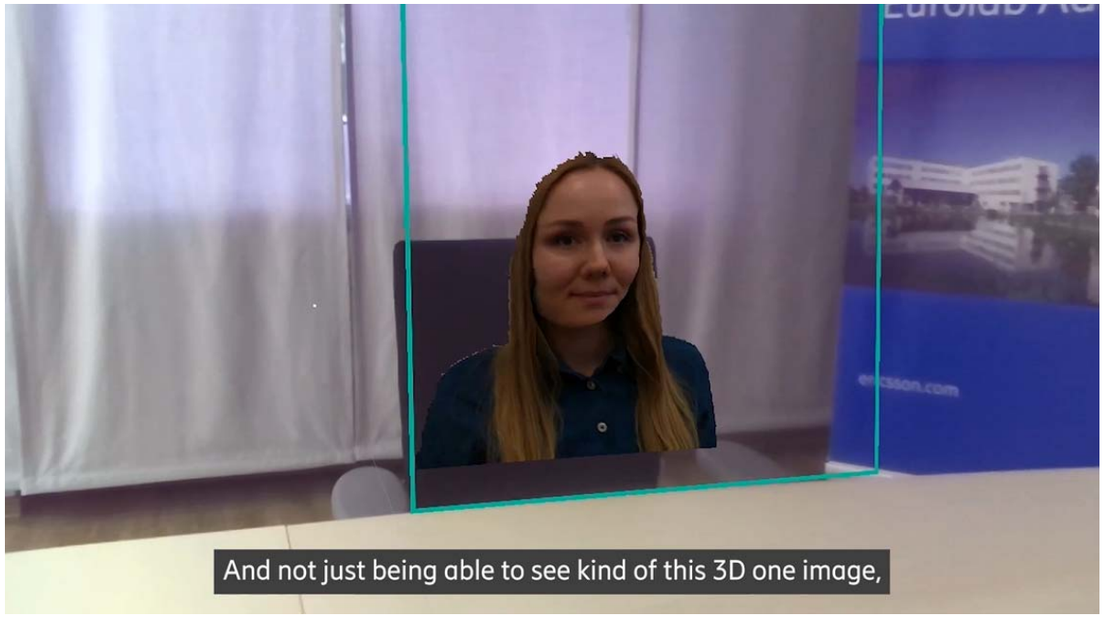
TECHNOLOGY FUTURES INC.

Immersive Art – Geraldine's Place (Art 84)

https://www.youtube.com/watch?v=xjfhgrYnMNQ

TECHNOLOGY FUTURES INC.

Holographic Glasses



With **Ericsson Holographic Communication**, the image is captured using consumer-grade phones or tablets, complemented by AI, to generate a full 3D holographic experience. This is made possible through leading-edge capabilities that **compress video from 2 Gbps to 30 to 50 Mbps**, which reduces the demand over the mobile network.

The compressed content is then transmitted to an off-the-shelf **XR device (such as glasses),** where the holographic stream is decoded and processed, before rendering in the user environment and displaying it accurately.

https://www.ericsson.com/en/about-us/new-world-of-possibilities/imagine-possible-perspectives/holographic-communication

TECHNOLOGY FUTURES INC.

Holographic Displays

PORTL

portlhologram.com/

https://www.nbcnews.com/nightly-news/video/stopping-by-ces-as-a-hologram-to-witness-the-future-of-tech-130219589573

David's [CEO David Nussbaum] vision for PORTL is to facilitate communication of all kinds that adds the emotional element that previous virtual methods lack. He wants to see a PORTL in every home streaming world class interactive hologram content and connecting people across every kind of divide. - PORTL

TECHNOLOGY FUTURES INC.

Holographic Displays

Looking Glass

No dystopian futures allowed.

We believe that the interfaces of the future won't be worn on your head 16 hours a day. They will be more like campfires glowing with three-dimensional fields of light that you can gather around with others. Sometimes in the same room, sometimes a world apart.

- Looking Glass

TECHNOLOGY FUTURES INC.

lookingglassfactory.com

Holographic Meeting Rooms

https://dveholographics.com/holo-meetings/

https://dveholographics.com/telepresence/

TECHNOLOGY FUTURES INC.

3D Holographic Display and Its Data Transmission Requirement

Xuewu Xu, Yuechao Pan, Phyu Phyu Mar Yi Lwin, and Xinan Liang
Data Storage Institute (DSI), A*STAR (Agency for Science, Technology and Research)
5 Engineering Drive 1, Singapore 117608, Singapore

Based on our analysis, the bandwidth requirement will increase to be in the range of 100 Gbps ~ 1 Tbps with the enhancement of system performance.

Two approaches using hologram data compression and object data transmission are discussed in order to solve the high bandwidth requirement problems.

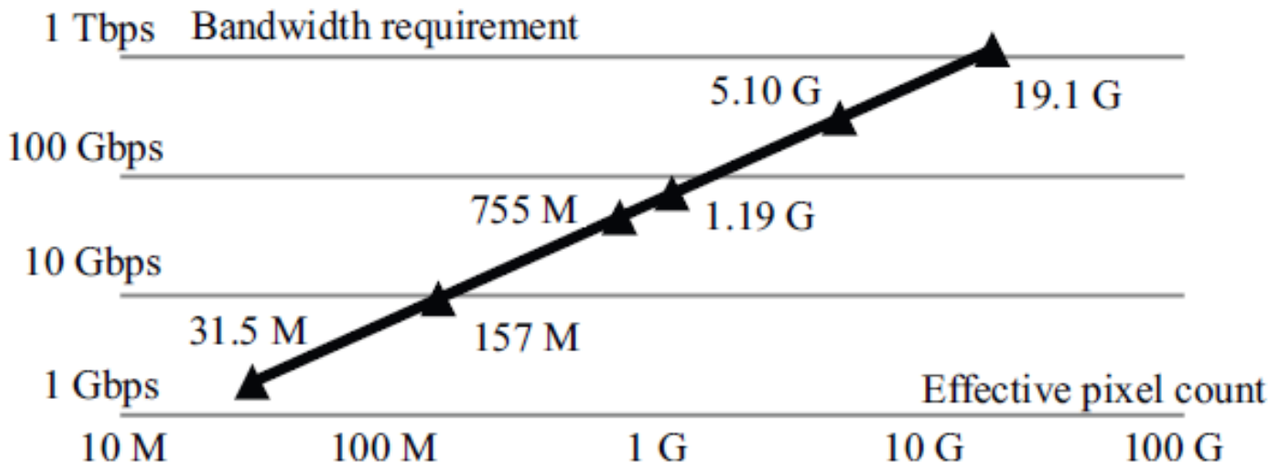


Fig. 6. Bandwidth requirement vs. effective pixel count.

TECHNOLOGY FUTURES INC.

Hologram Data Rates

	Horz Pixels	x	Vert Pixels	x	Bits/ Pixel	x	Frame s/sec	x	Depth	x	Lens	=	Raw bits/sec	Raw Gb/s	Compressed Comp Ratio	Compressed Gb/s
Hologram 4k	3840		2160		24		60		24		1		286,654,464,000	287	100	2.9
Hologram 8k	7680		4320		24		60		24		1		1,146,617,856,000	1,147	100	11.47
Hologram 4k -360	3840		2160		24		60		24		6		1,719,926,784,000	1,720	100	17.20
Hologram 8k -360	7680		4320		24		60		24		6		6,879,707,136,000	6,880	100	68.80

TECHNOLOGY FUTURES INC.

How Long Will Broadband Speeds Increase?

Key Technology Forecasting Principle:

- Performance improvement will continue as long as it's:
  - Technically feasible AND
  - Useful

- The rate may change if the technology approach changes.

- 10 Gb/s for sure – after that, who knows?

TECHNOLOGY FUTURES INC.

(512) 415-5965 • www.tfi.com

Your Bridge to the Future

TECHNOLOGY FUTURES INC.