

6G



6G Mobile Wireless Communications

Vision, Roadmap, Technologies & Use Cases

6G Devices

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FEBRUARY 2021

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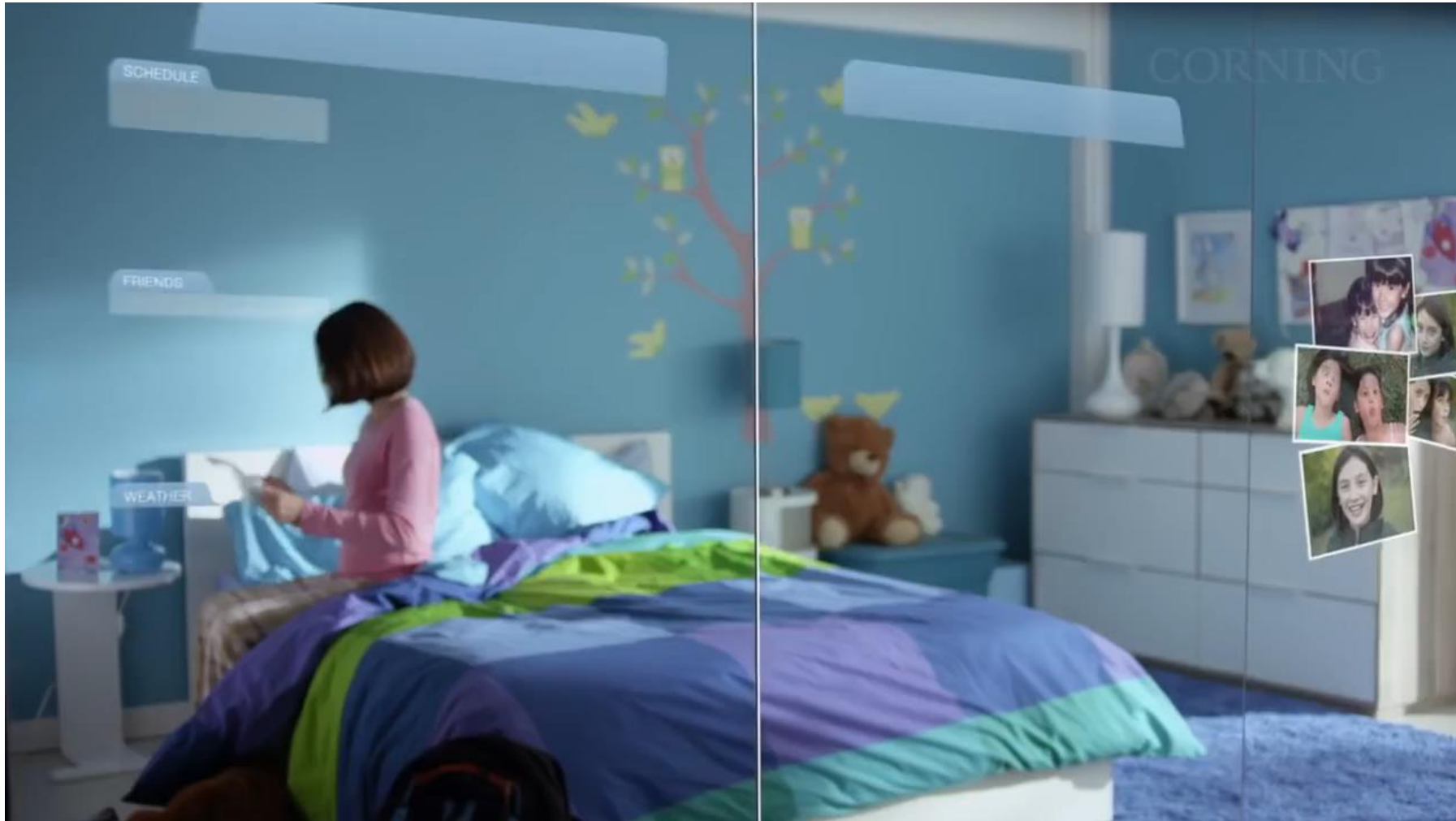
@3g4gUK

What do you think are 6G Devices?



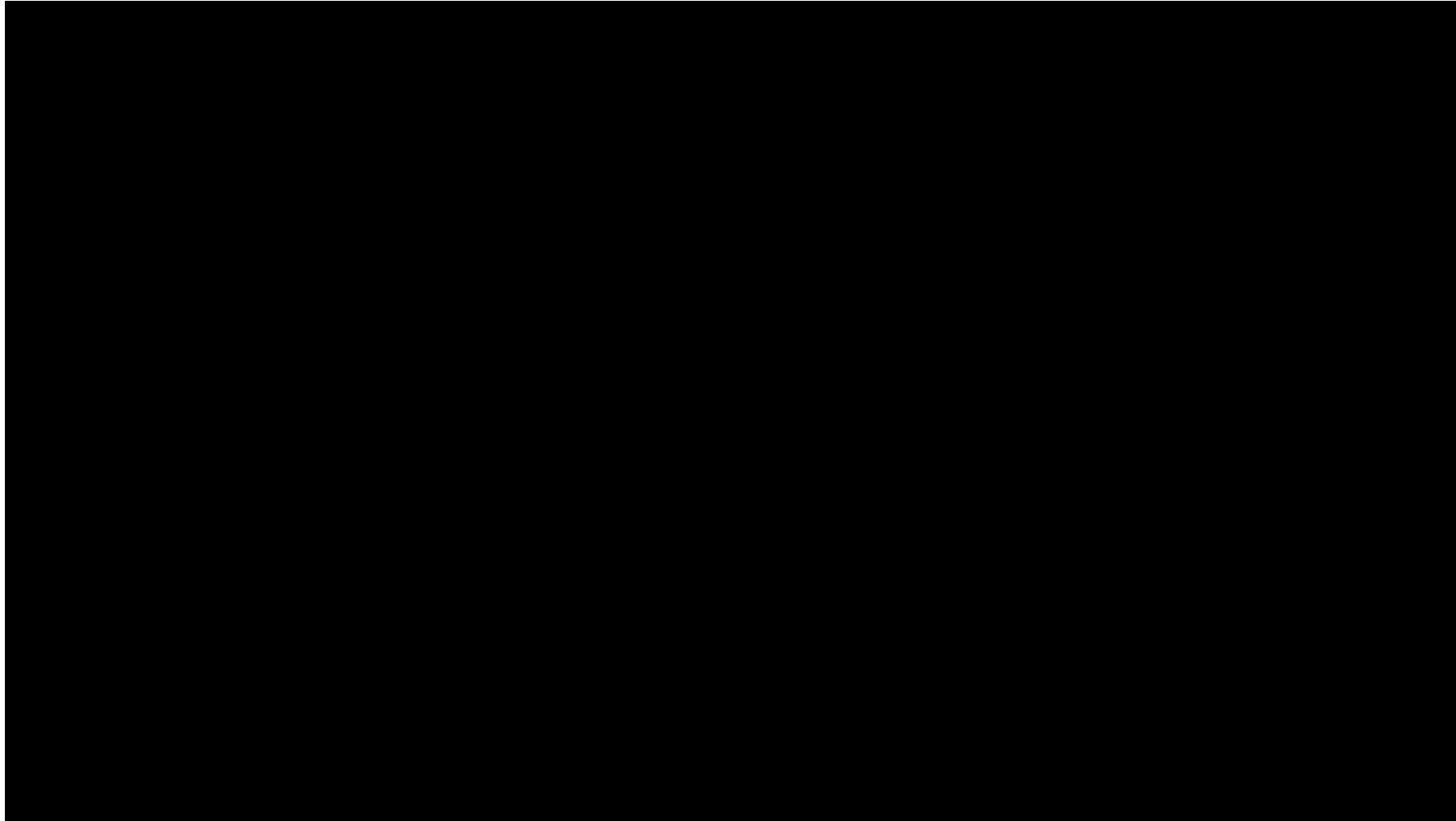
Source: Microsoft HoloLens MR Video [link](#)

What do you think are 6G Devices?



Source: Corning - A Day Made of Glass

What do you think are 6G Devices?

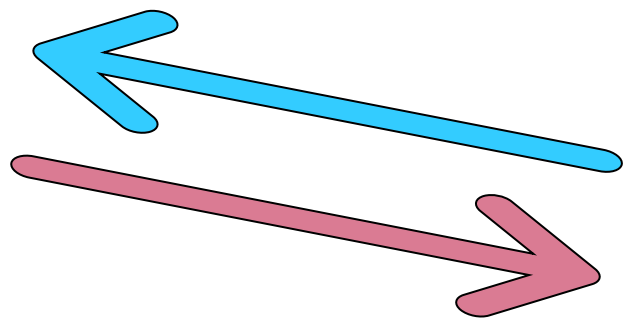


Source: Ericsson - A Social Web of Things

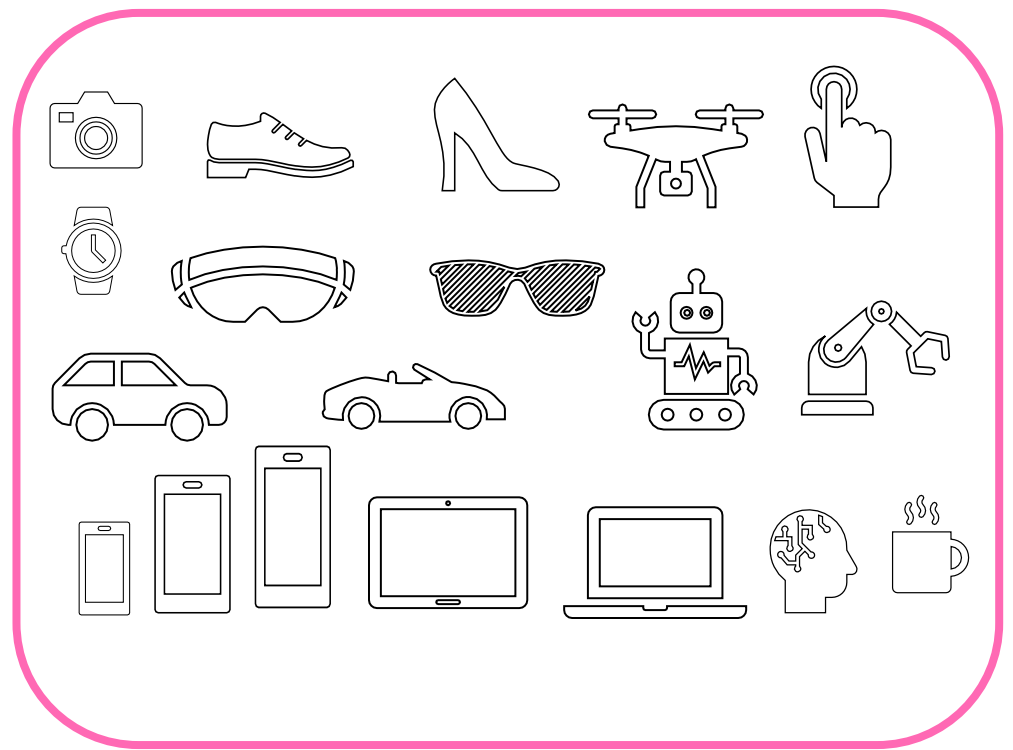
What's stopping us from
turning Science Fiction into
Reality?



6G Network



6G Connectivity

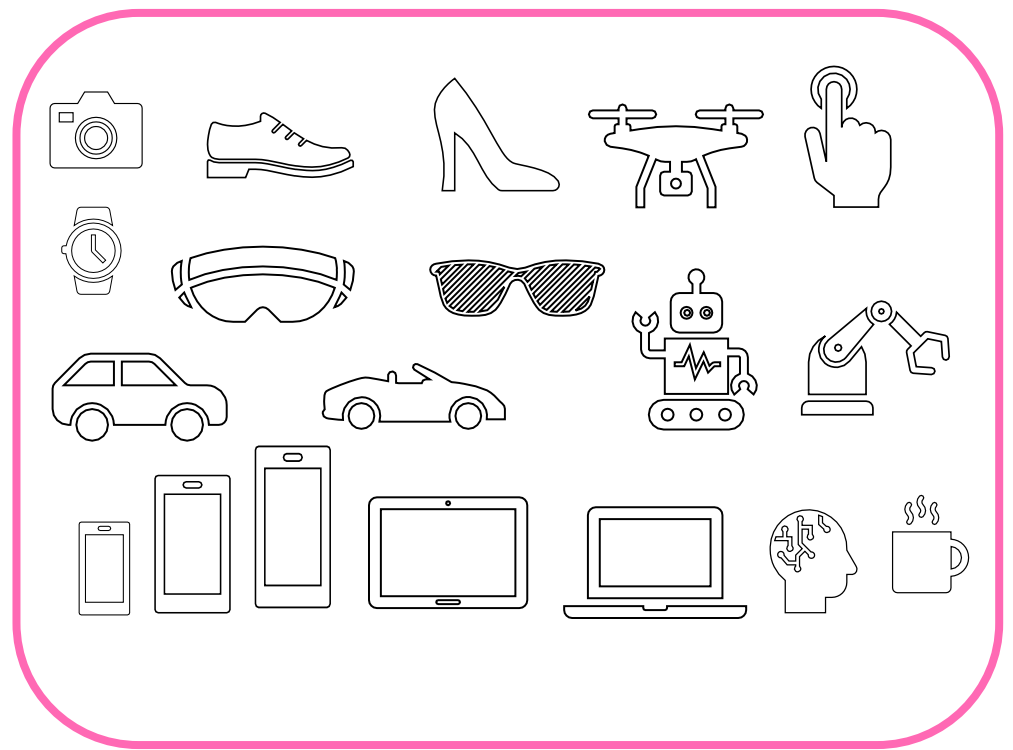
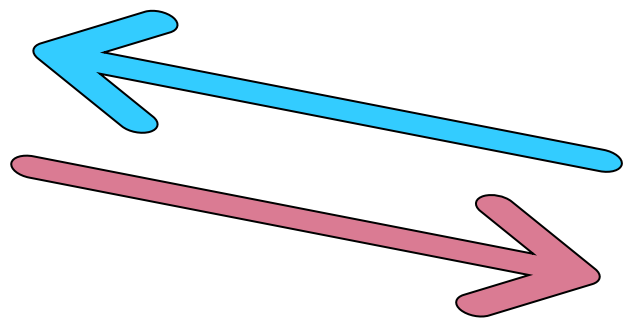


6G Devices

Network & Architecture Evolution

Access Network Evolution

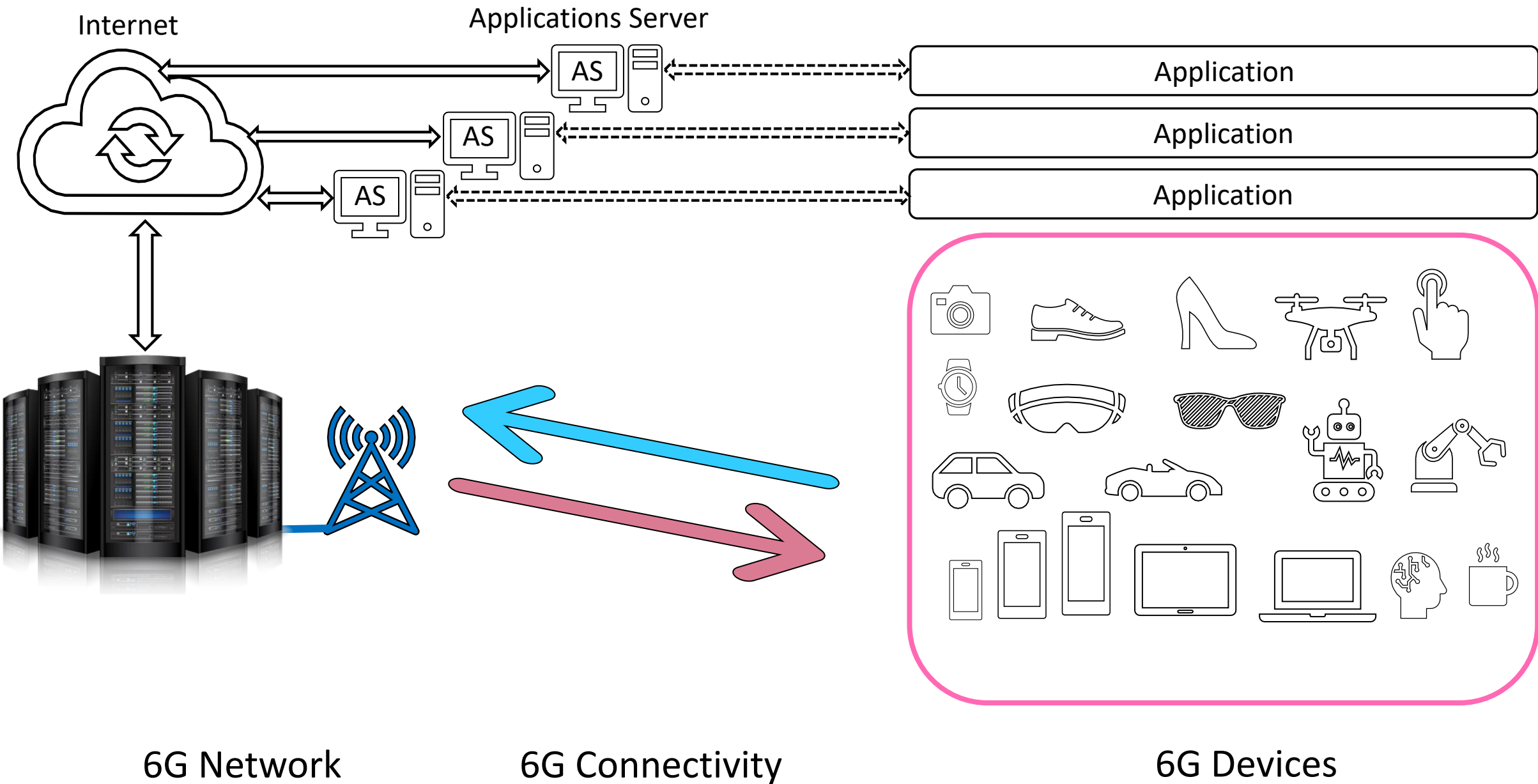
Devices and Components Evolution



6G Network

6G Connectivity

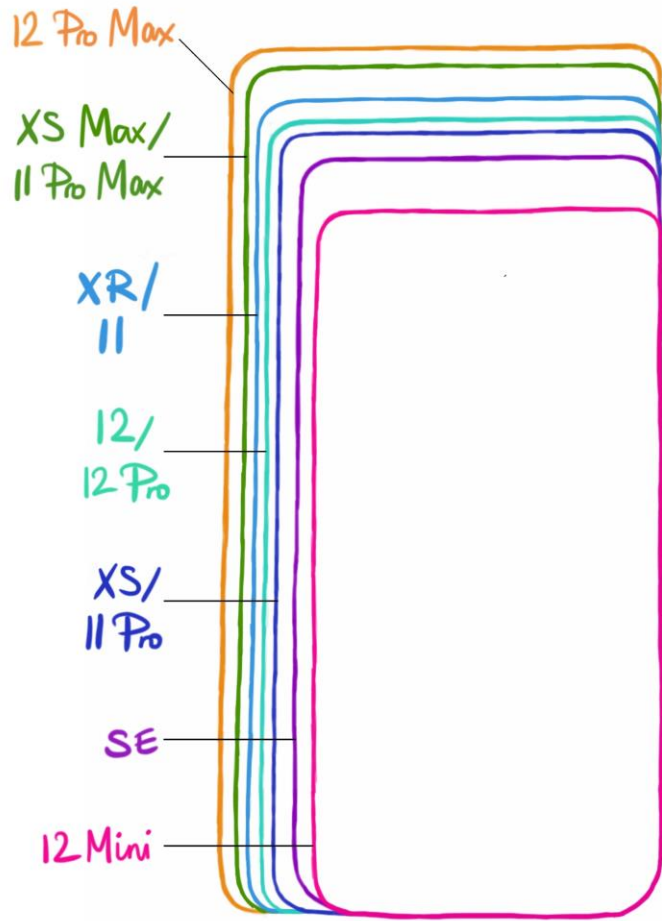
6G Devices



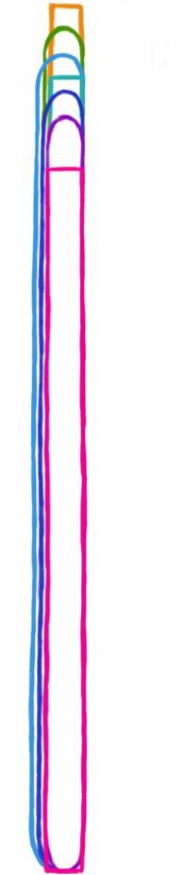
From Phones to Smartphones and Smart Featurephones



iPhone Size Comparison Over the Years



Source: [Kate Matthews](#)



RHL--



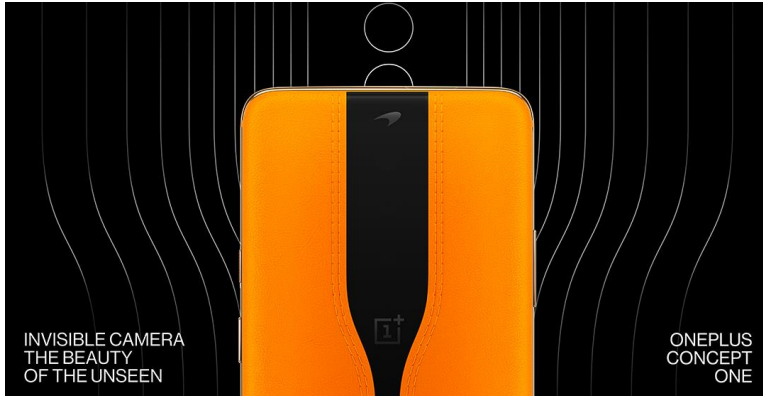
Picture [Source](#)

Good summary of history of iPhones and evolution ([link](#))
 Comparison of iPhone 12 with the original iPhone SE ([link](#))

Smartphones Innovation in 2020

(Click on the picture to read more about them)

Based on article from [TechRadar](#)



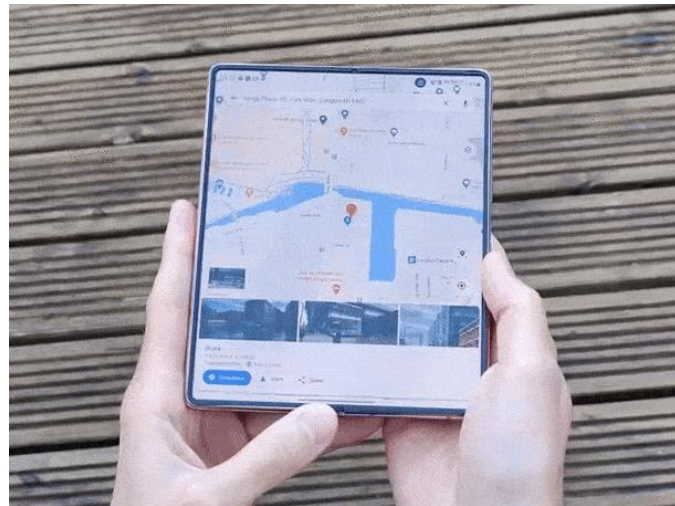
Oneplus Concept One



Motorola Razer Foldable



LG Wing 5G



Samsung Galaxy Z Fold 2



ZTE Axon 20 5G



Oppo X Nendo

Tablets & Laptops



Surface Book 3



MacBook Pro



Lenovo Tab P11 Pro



Dell 2-in-1



iPad



Samsung Galaxy Tab A7

Rise of the Companion Devices

What exactly are Companion Devices?

Companion Devices are designed to work with a 'main' or 'parent' device which generally needs to accompany them.

Examples of companion devices could be smartwatches or Bluetooth headset or any other wearables, wherein they generally only work with a Smartphone or a Tablet, which is the main device.

Example of Companion Devices



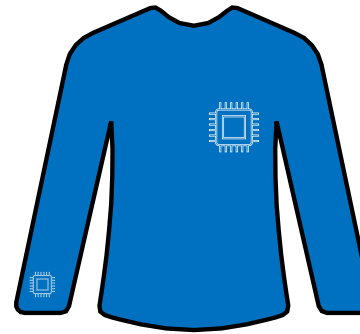
Smaller
Companion
Phones



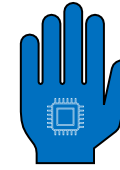
Smart Watches and
Fitness Trackers



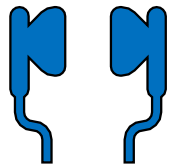
XR Headsets



Smart Clothing



Electronic Skin
Patches



Hearables

Apple Watch Healthcare

Compare Apple Watch Models

	High Heart Rate Notification	Low Heart Rate Notification	Irregular Rhythm Notification	ECG App	Fall Detection
Sensors	Optical heart sensor / PPG	Optical heart sensor / PPG	Optical heart sensor / PPG	Electrical heart sensor / electrodes	Next-generation accelerometer and gyroscope
Apple Watch Series 1, 2, 3	✓	✓	✓	✗	✗
Apple Watch Series 4 or later	✓	✓	✓	✓	✓

Note: Original Apple Watch does not support these functions

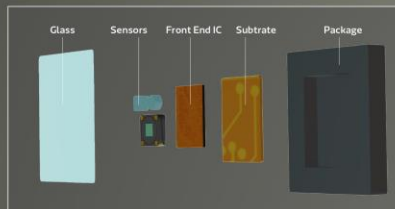


Source: [Apple](https://apple.com)

MediaTek Sensio™: Your Personal Health Companion

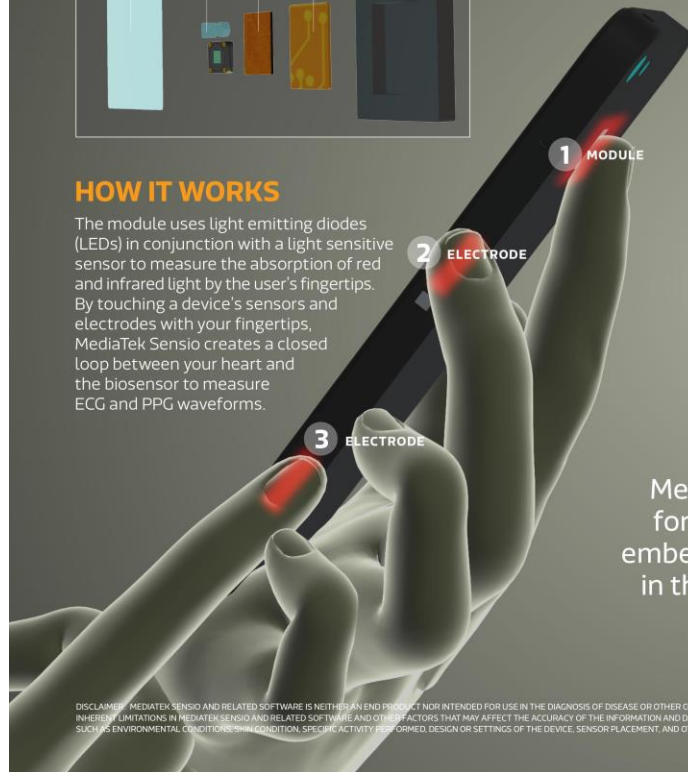
HARDWARE

The MediaTek Sensio module puts complex features in a compact design. It's a flexible embedded solution with our in-house algorithm that can read and process the measurements. Biological information is measured through the module and the electrodes.



HOW IT WORKS

The module uses light emitting diodes (LEDs) in conjunction with a light sensitive sensor to measure the absorption of red and infrared light by the user's fingertips. By touching a device's sensors and electrodes with your fingertips, MediaTek Sensio creates a closed loop between your heart and the biosensor to measure ECG and PPG waveforms.



MediaTek Sensio™

YOUR PERSONAL HEALTH COMPANION

MT6381

The world's first highly integrated 6-in-1 biosensor module for smartphones, measures **6 functions** in nearly 60 seconds

MediaTek Sensio makes it possible for smartphone manufacturers to embed a convenient biosensor module in their devices to quickly check and monitor physical wellness

SOFTWARE

With MediaTek Sensio, manufacturers are able to develop proprietary applications or leverage third-party applications and developer add-ons.

The MediaTek Sensio MT6381 is a comprehensive software and module solution designed specifically to deliver valuable health data, consisting of optical, electrical and processing components.

- 1 SpO₂**
Peripheral Oxygen Saturation measures the amount of oxygen in the blood.
- 2 Heart Rate**
MediaTek Sensio measures heart beats per minute.
- 3 Blood Pressure Trends**
Measures blood pressure trends help users see data over a period of time.
- 4 Heart Rate Variability**
Measures variation in the time between heartbeats.
- 5 ECG & PPG**
Electrocardiography measures the electrical activity of the heart over a period of time and displays it in graph form & Photoplethysmography measures the change in volume of blood.
- 6**



DISCLAIMER: MEDIATEK SENSIO AND RELATED SOFTWARE IS NEITHER AN END PRODUCT NOR INTENDED FOR USE IN THE DIAGNOSIS OF DISEASE OR OTHER CONDITIONS, OR IN THE CURE, MITIGATION, TREATMENT OR PREVENTION OF DISEASE. THERE ARE INHERENT LIMITATIONS IN MEDIATEK SENSIO AND RELATED SOFTWARE AND OTHER FACTORS THAT MAY AFFECT THE ACCURACY OF THE INFORMATION AND DATA PROVIDED BY MEDIATEK SENSIO AND RELATED SOFTWARE, INCLUDING HEART RATE READINGS, SUCH AS ENVIRONMENTAL CONDITIONS, PHYSICAL CONDITION, SPECIFIC ACTIVITY PERFORMED, DESIGN OR SETTINGS OF THE DEVICE, SENSOR PLACEMENT, AND OTHER END-USER INTERACTIONS.



Source: MediaTek

Wearable 360° Cameras

NEXX360



NEXX360 [Details](#)

FITT360



FITT360 [Details](#)

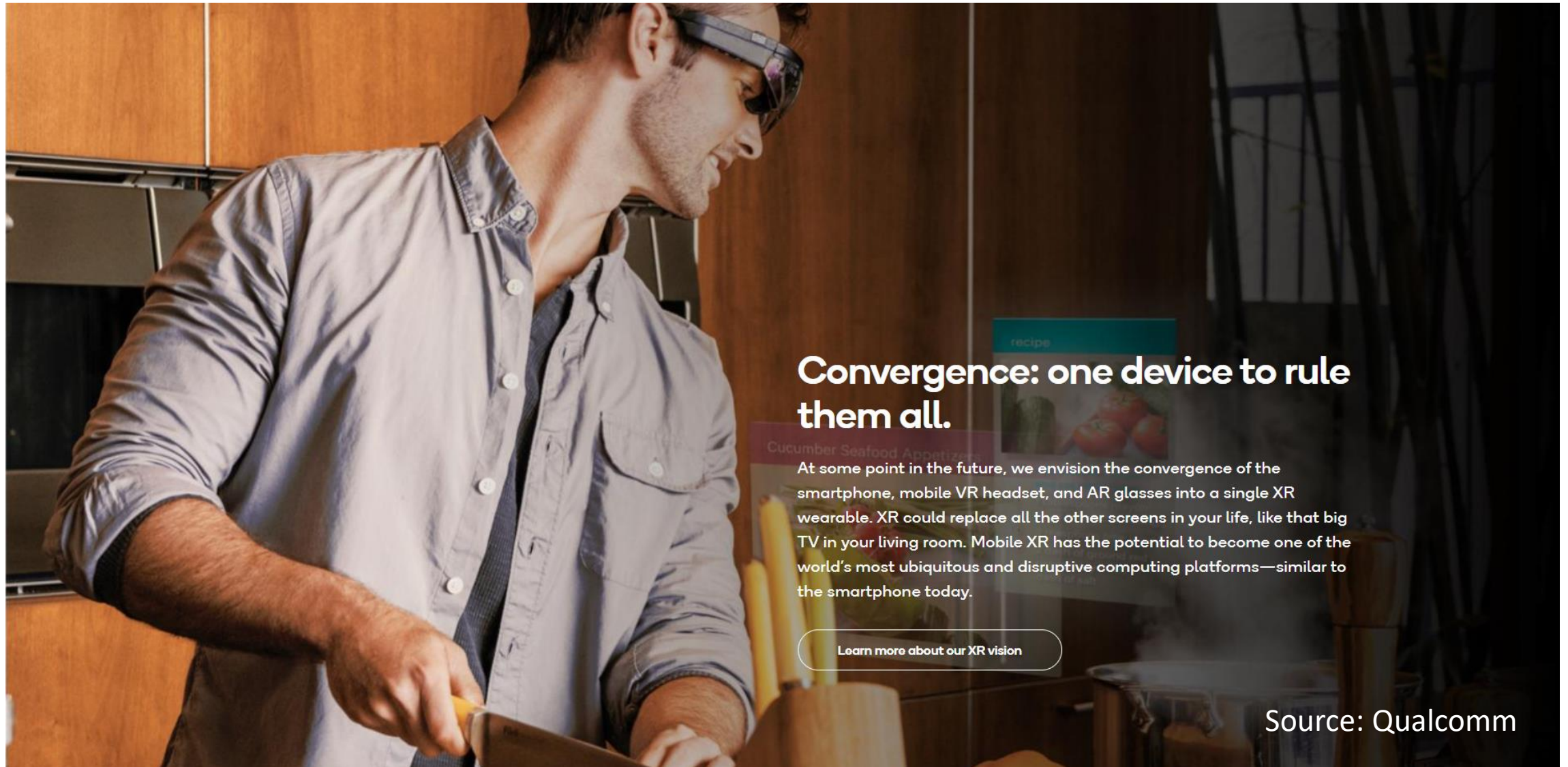
See [Linkflow](#)

360° Camera Usage Example



Source: [KT](#)

Qualcomm's Vision: one XR device to rule them all!



Convergence: one device to rule them all.

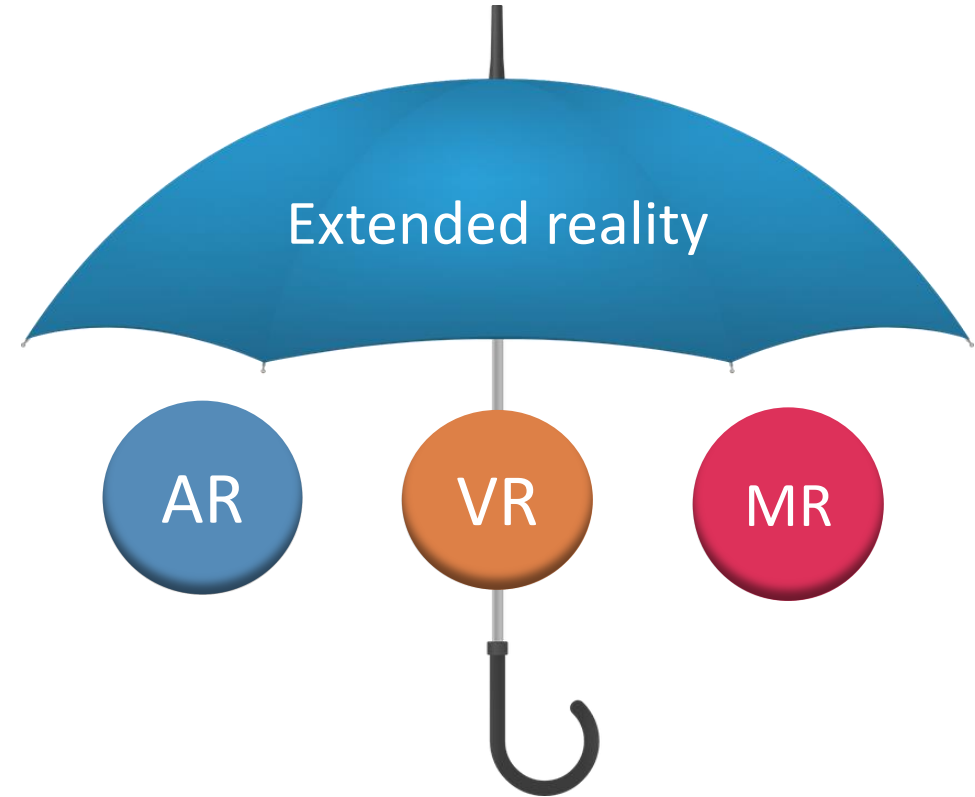
At some point in the future, we envision the convergence of the smartphone, mobile VR headset, and AR glasses into a single XR wearable. XR could replace all the other screens in your life, like that big TV in your living room. Mobile XR has the potential to become one of the world's most ubiquitous and disruptive computing platforms—similar to the smartphone today.

[Learn more about our XR vision](#)

Source: Qualcomm

Extended Reality (XR)!

Extended Reality (XR) is an umbrella term for all the immersive technologies.



VIRTUAL REALITY HEAD MOUNTED DEVICES



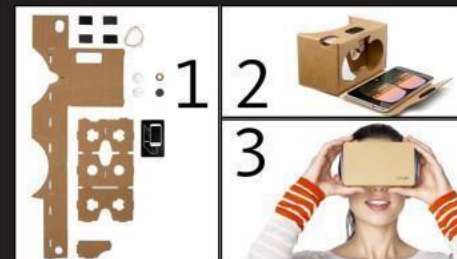
OCULUS



HTC VIVE



SAMSUNG GEAR



GOOGLE
CARDBOARD



POWIS
CARDBOARD

AUGMENTED REALITY HEAD MOUNTED DEVICES



MICROSOFT
HOLOLENS



MAGIC LEAP



MIRA PRISM

Nreal Mixed Reality Glasses Kit



Nreal Light Dev Kit

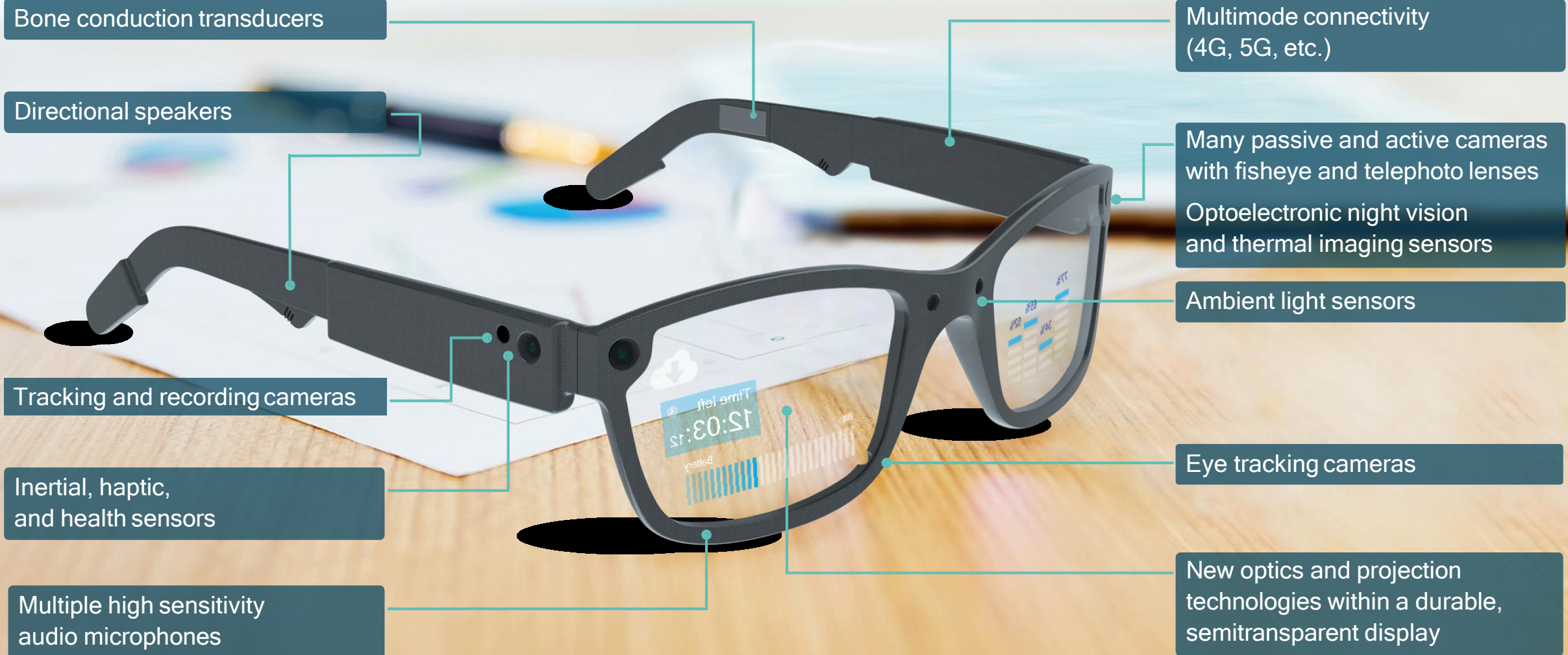
- Nreal Light Glasses x 1
- Nreal Light Computing Unit x 1
- Nreal Light Controller x 1
- Corrective Lens Frames x 1
- The Clip x 1
- Nose Pads x 3
- USB-C Cable x 1
- Charger x 1
- Nreal Light Glasses Cleaning Cloth x 1
- User Guide x 1

Unit Price: **\$1,199**

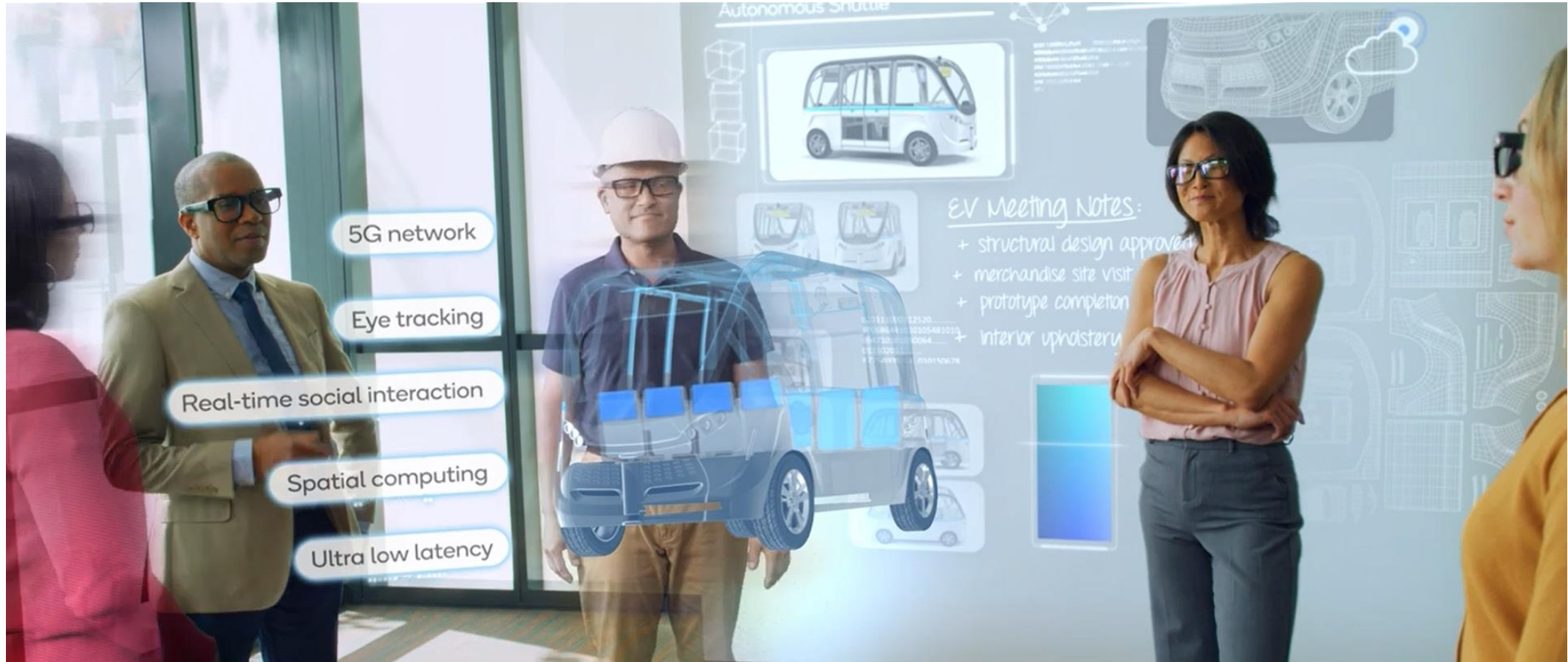
Quantity: **\$0**

Source: [Nreal](https://www.nreal.com)

A glimpse into the future — everyday AR glasses



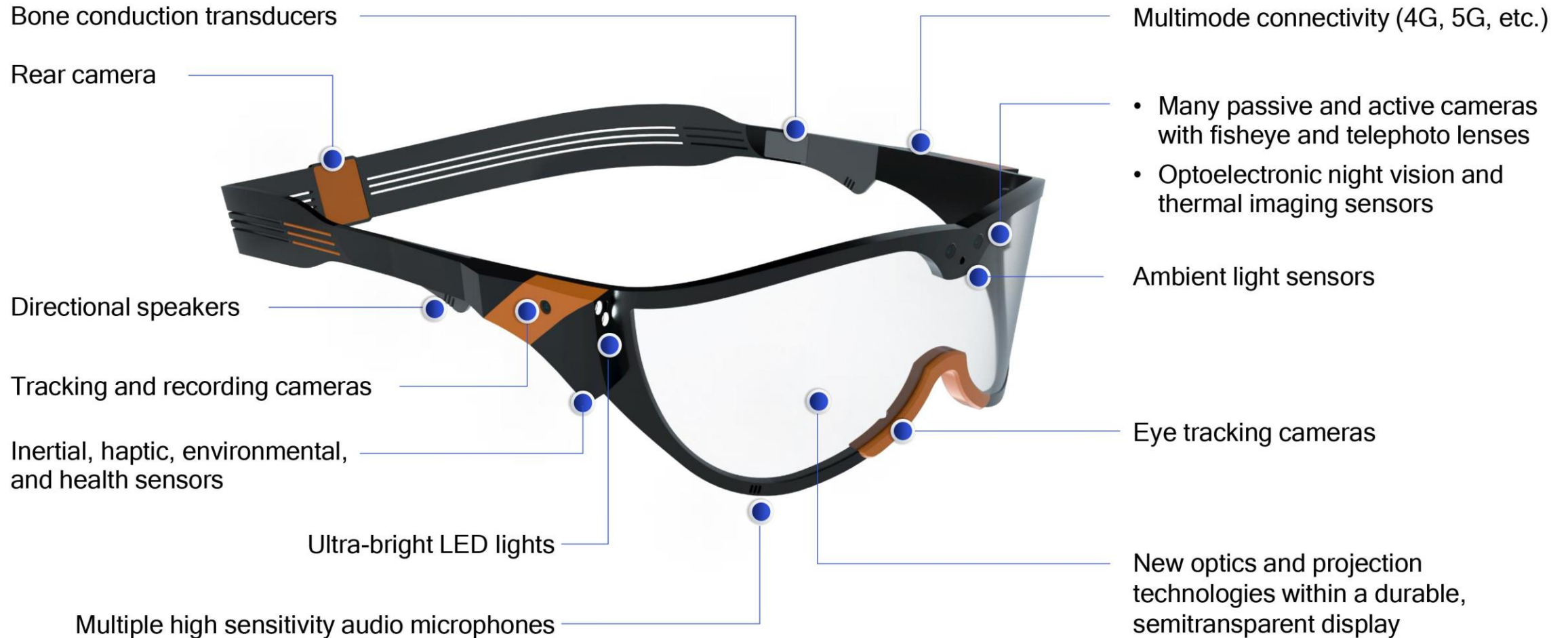
Collaboration Over Immersive XR



Source: [Qualcomm](#)

A glimpse into the future

First responder XR glasses



XR Devices and Form Factors

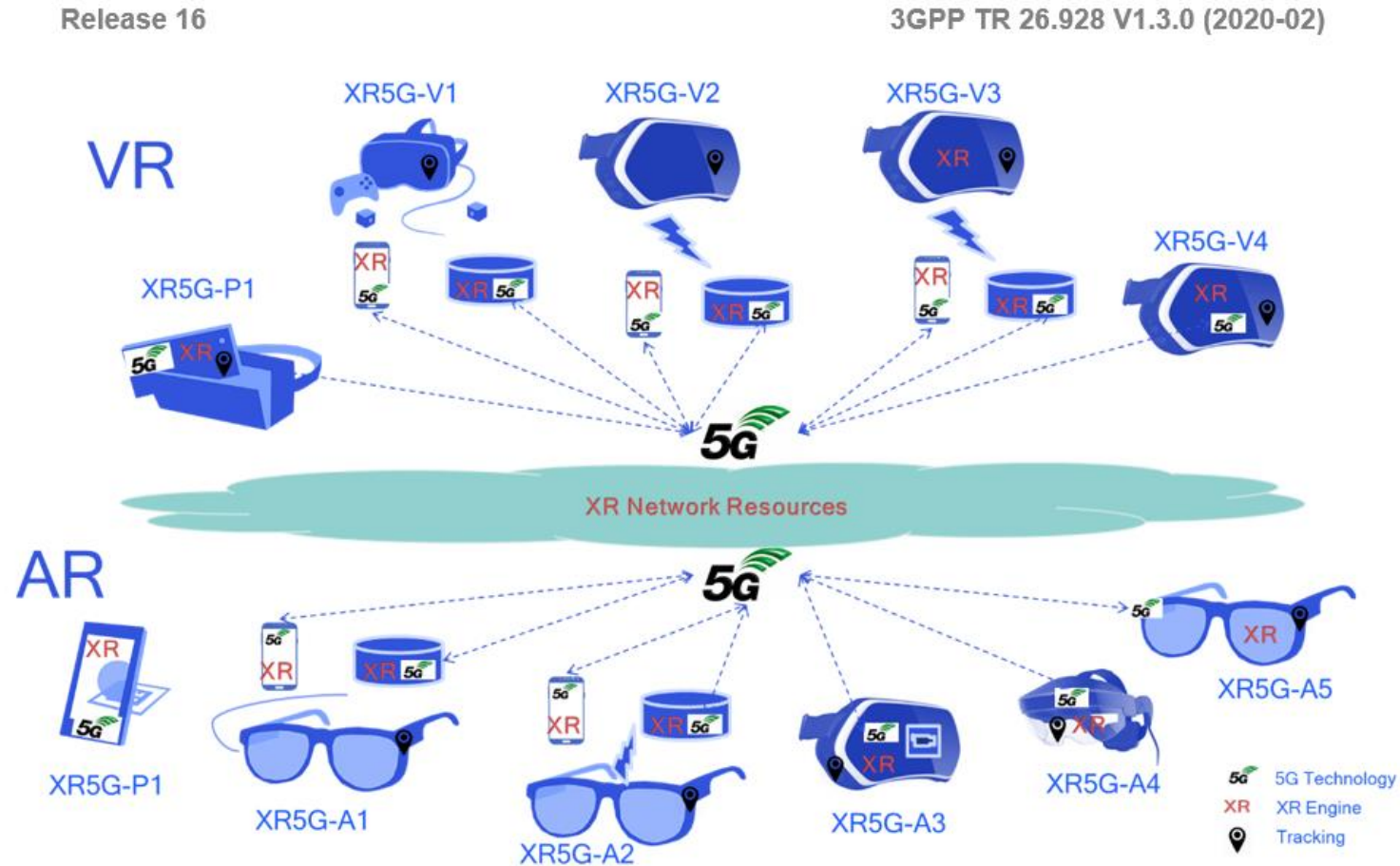


Figure 4.8-1: XR Form Factors

XR Devices and Form Factors

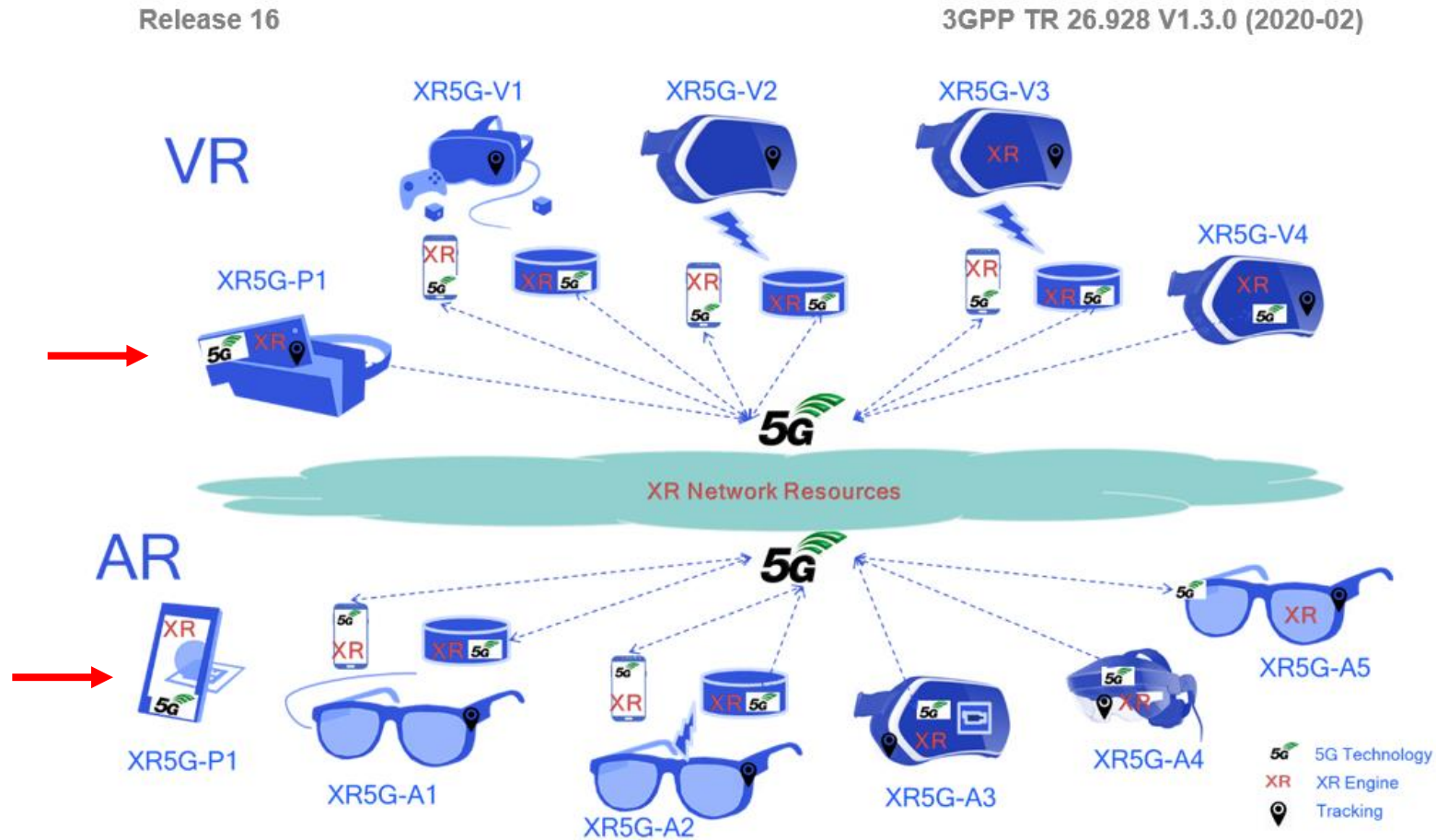


Figure 4.8-1: XR Form Factors

XR Devices and Form Factors

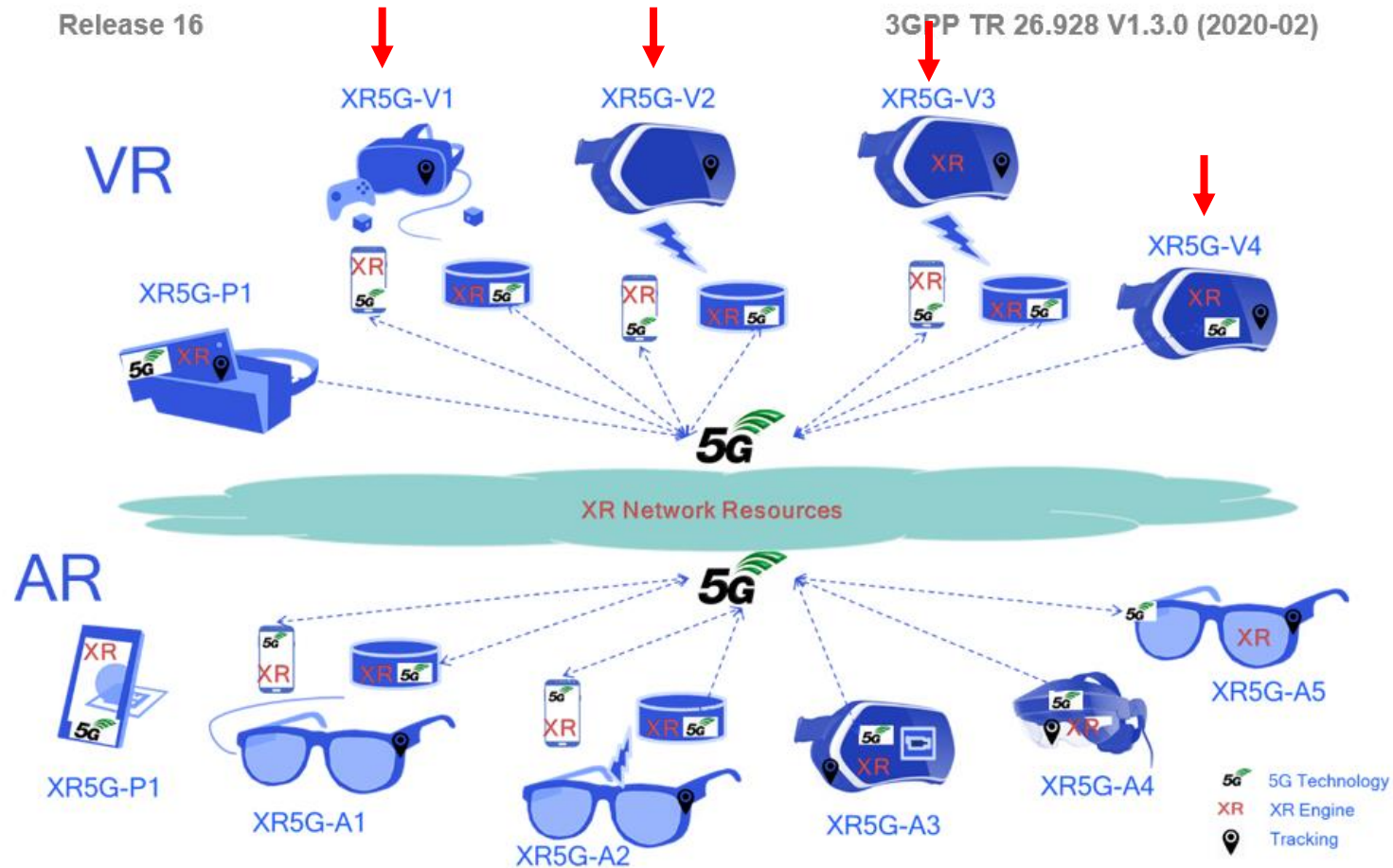


Figure 4.8-1: XR Form Factors

XR Devices and Form Factors

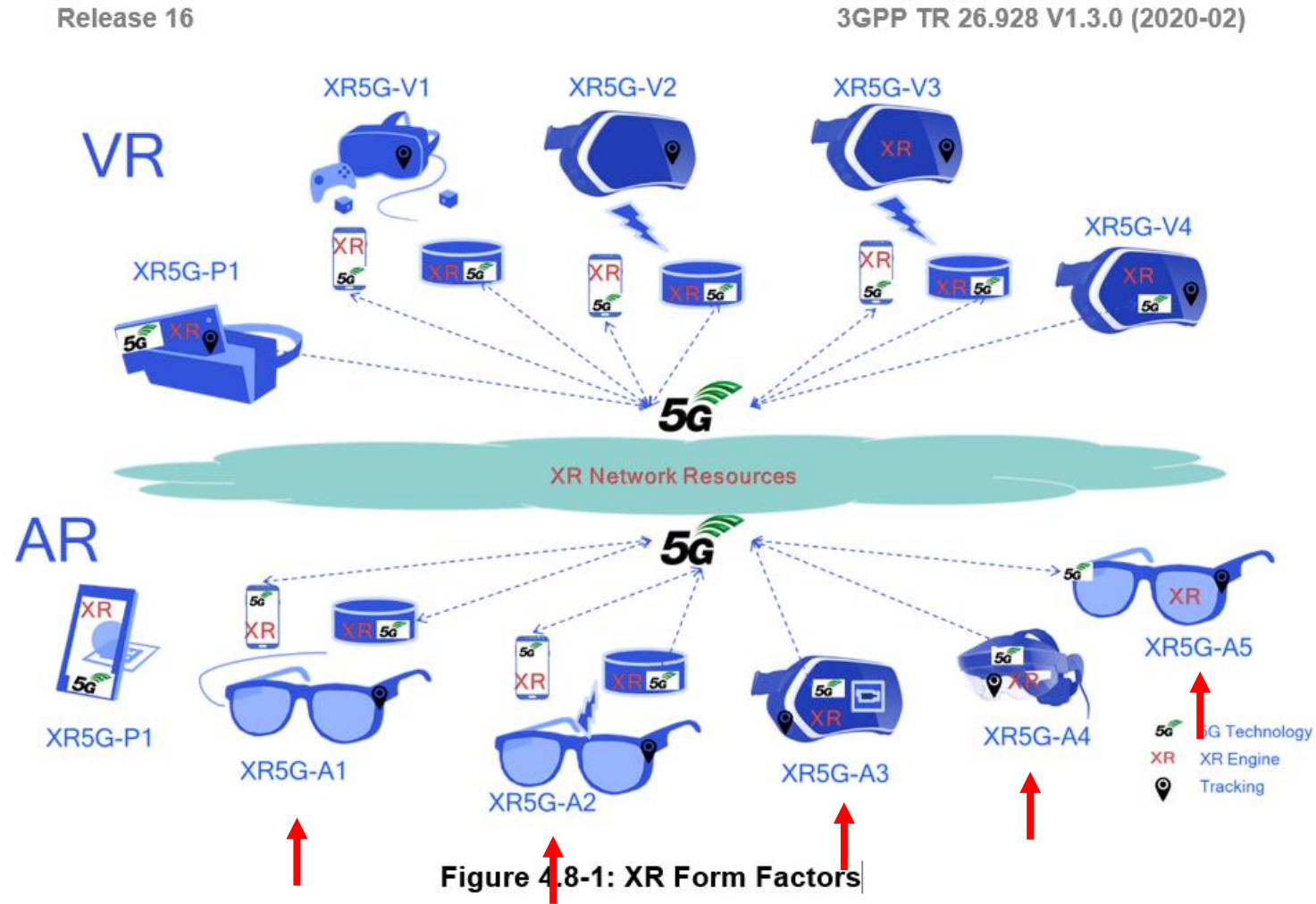


Figure 4.8-1: XR Form Factors

Summary of XR Device Types (3GPP TR 26.928)

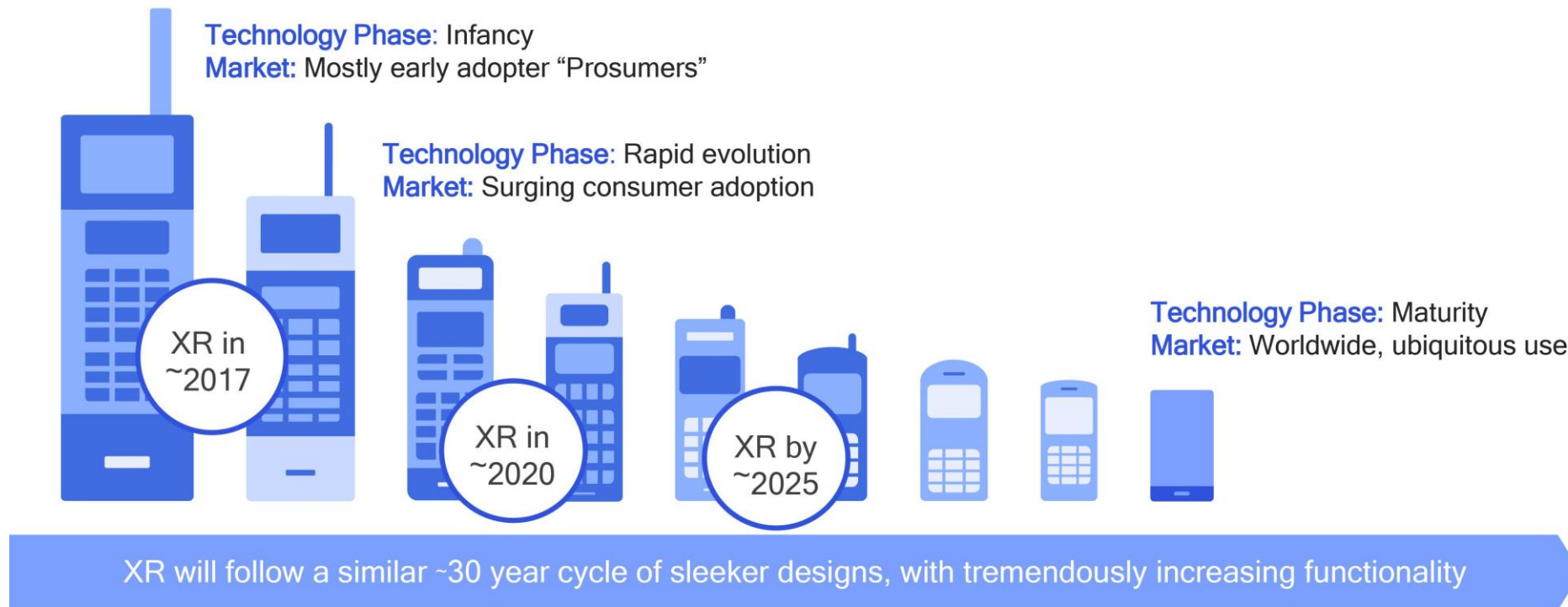
XR Type Number	XR Device Type Name	Tethering Examples	5G Uu Modem	XR Engine Localization	Power Supply	Typical Max Avail Power
XR5G-P1	Phone	n/a	XR device	XR device or split	Internal	3-5 W
XR5G-V1	Simple VR Viewer wired tethering	USB-C	External	External	External	2-5 W
XR5G-V2	Simple VR Viewer wireless tethering	802.11ad/y, 5G sidelink, etc.	External	External	Internal	2-3 W
XR5G-V3	Smart VR Viewer wireless tethering	802.11ad/y, 5G sidelink, etc.	External	XR device or Split	Internal	2-3 W
XR5G-V4	VR HMD Standalone	n/a	XR device	XR device or Split	Internal	3-7 W
XR5G-A1	Simple AR Wearable Glass wired tethering	USB-C	External	External	External	1-3 W
XR5G-A2	Simple AR Wearable Glass wireless tethering	802.11ad/y, 5G sidelink. etc.	External	External	Internal	0.5 – 2 W
XR5G-A3	Smart AR HMD see-through standalone	n/a	XR device	XR device or Split	Internal	3-7 W
XR5G-A4	AR Wearable Glass standalone	n/a	XR device	XR device or Split	Internal	2 - 4 W
XR5G-A5	Smart AR Wearable Glass wireless tethering	802.11ad/y, 5G sidelink. etc.	External	XR device or Split	Internal	0.5 – 2 W

XR Evolution Roadmap

Source: Qualcomm

XR is here today, but it is still in its infancy

Analogy to smartphones: XR evolution will take years...opportunity will be immense

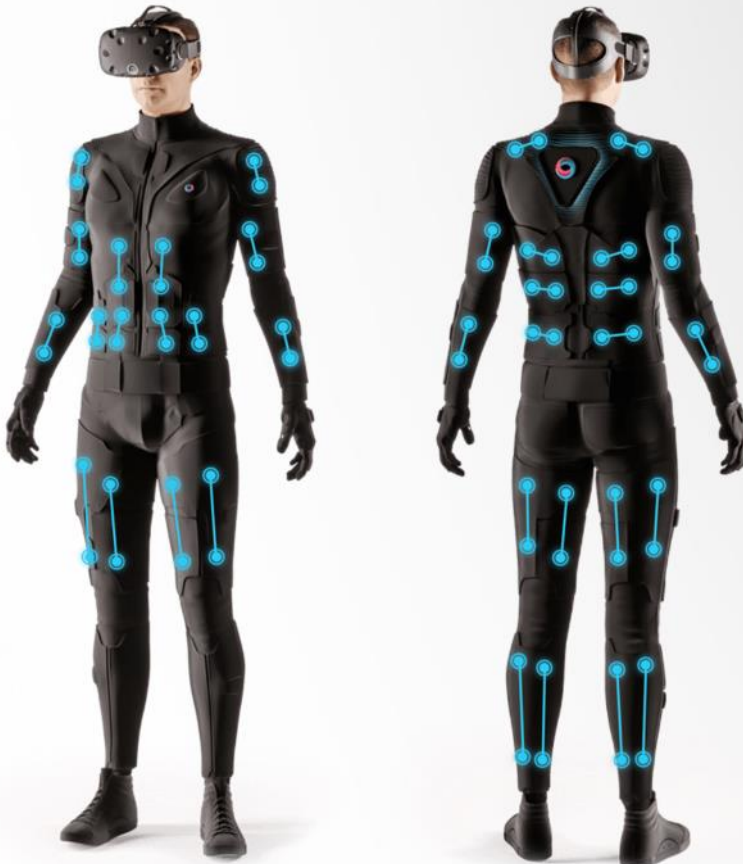


9

Outstanding Challenges with XR Evolution

- Virtual Objects look Fake
- Improvements needed in motion tracking
 - Improved head/body tracking
 - Improved eye tracking
- Poor Battery Life
- Charging time
- Fast Switch-on
- Able to handle large amount of computation, without getting hot
- High speed connectivity, indoors and outdoors
- Low latency (zero lag)
- Weight
- High Cost

Wearables – TESLASUIT ([link](#))



68
Haptic ports

Haptic Animations

Real-time
Simulations

Weight Simulation

User calibration profiles

Capillary system

Haptic Library

Users can create custom animations with Haptic Editor application

Pic [source](#)

Teslasuit relies on 2.4GHz Wi-Fi for connectivity today. Could it be using 5G/6G in future?

World's first 5G haptic rugby tackle by VF UK



Source: Vodafone UK [YouTube](#)

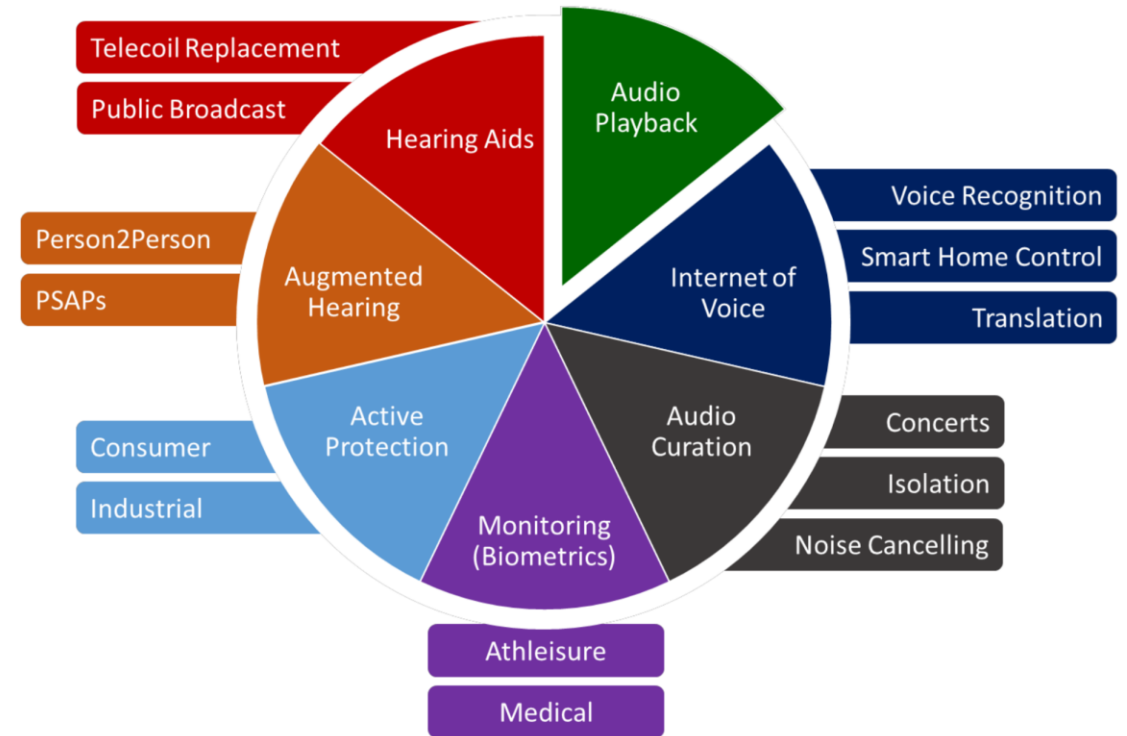
Wearables – Contextually-Aware Fragrances



More Details: escent.ai

See this [presentation](#) on CW

Hearables

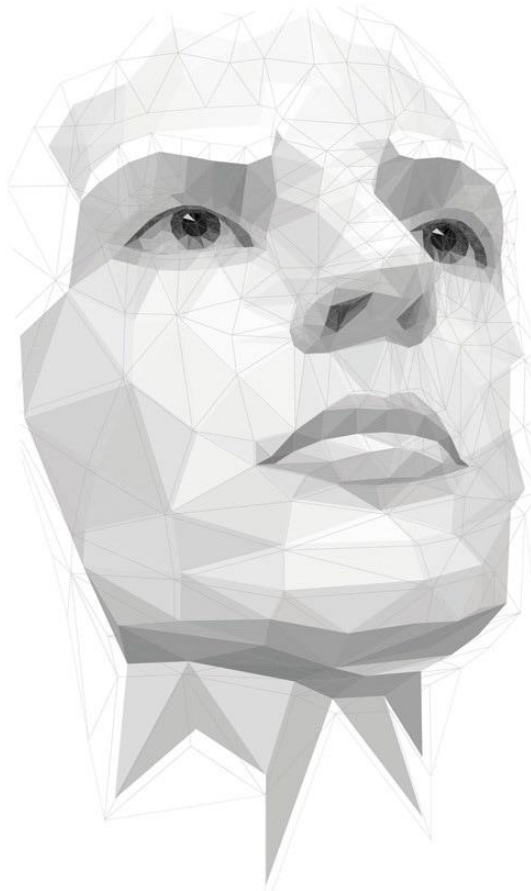


Pictures source: [Fashnerd](#)

Ericsson's 2030 Trends: Internet of Senses

10 Hot Consumer Trends 2030

Welcome to the internet of the senses.



01. Your brain is the user interface

Fifty-nine percent of consumers believe that we will be able to see map routes on VR glasses by simply thinking of a destination.

02. Sounds like me

Using a microphone, 67 percent believe they will be able to take on anyone's voice realistically enough to fool even family members.

03. Any flavor you want

Forty-five percent predict a device for your mouth that digitally enhances anything you eat, so that any food can taste like your favorite treat.

04. Digital aroma

Around 6 in 10 expect to be able to digitally visit forests or the countryside, including experiencing all the natural smells of those places.

05. Total touch

More than 6 in 10 expect smartphones with screens that convey the shape and texture of the digital icons and buttons they're pressing.



06. Merged reality

VR game worlds are predicted by 7 in 10 to be indistinguishable from physical reality by 2030.



07. Verified as real

"Fake news" could be finished – half of respondents say news reporting services that feature extensive fact checks will be popular by 2030.



08. Post-privacy consumers

Half of respondents are "post-privacy consumers" – they expect privacy issues to be fully resolved so they can safely reap the benefits of a data-driven world.



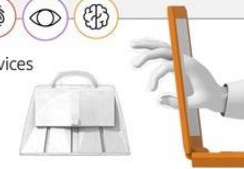
09. Connected sustainability

Internet of senses-based services will make society more environmentally sustainable, according to 6 in 10.



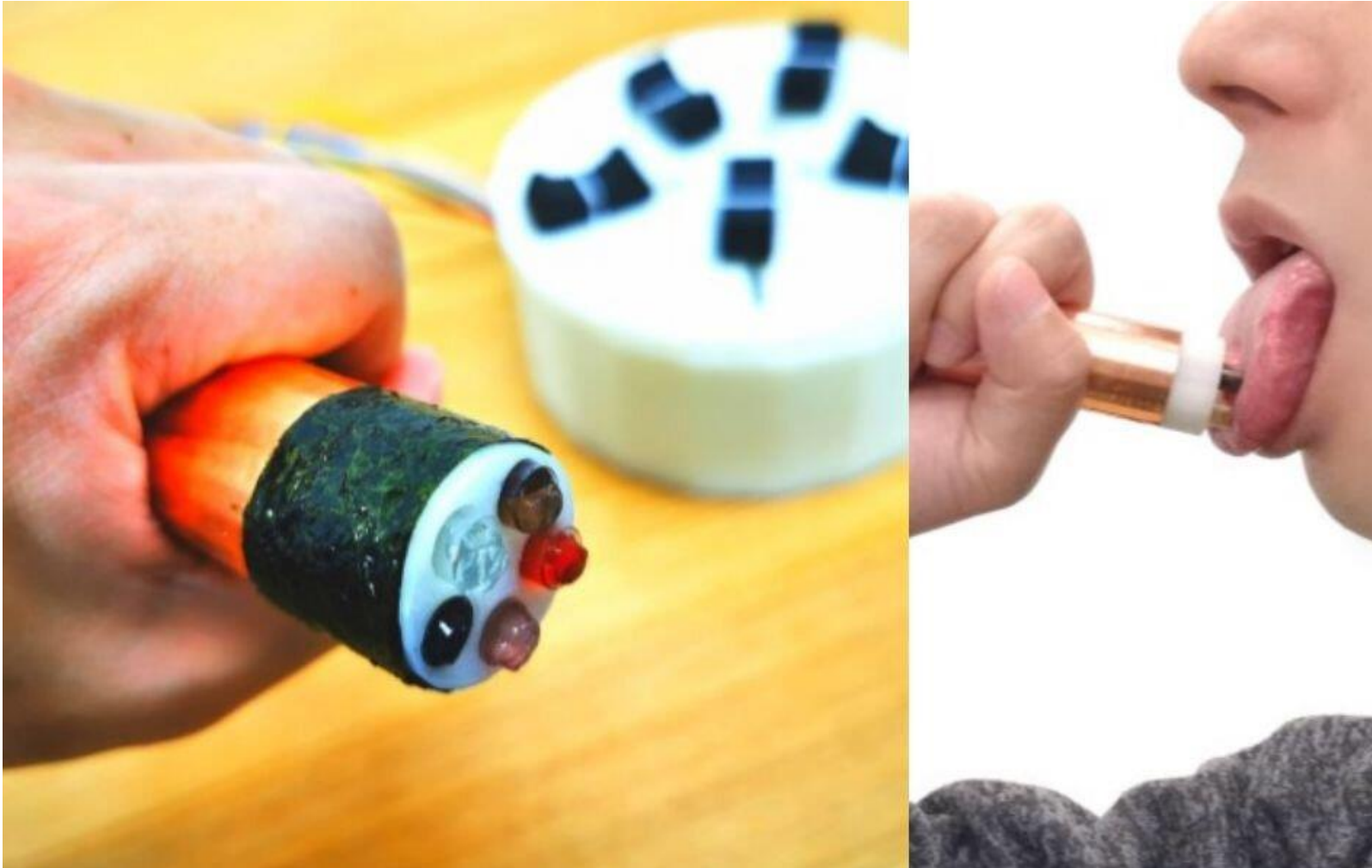
10. Sensational services

Forty-five percent of consumers anticipate digital malls allowing them to use all five senses when shopping.



Watch the 'Internet of senses' video [here](#)

“Lickable Screen” device



Source: [TechXplore](#)

'Zero-Energy' or 'Extreme-low power' Devices



Figure 3-4. Extreme-low power consumption and cost reduction

Picture Source: NTT Docomo 6G Whitepaper



Background Material

- Corning: A Day Made of Glass Video Series ([link](#))
- Ericsson: A Social Web of Things ([link](#))
- The 3G4G Blog: 5G eXtended Reality (5G-XR) in 5G System (5GS) ([link](#))
- GSMA: The activities of GSMA on 5G and Cloud AR/VR ([link](#))

Further Reading

- University of Oulu: 6G vision for 2030 (video [link](#))
- EE Times: Have Wearables Found Their True Killer App?, Nitin Dahad, April 2018 ([link](#))
 - Cambridge Wireless: Scenarios for smart devices in 2025, David Wood, March 2018 ([link](#))(summary on 3G4G [blog](#))
- BBC - CES 2020: Nreal's mixed reality glasses win over sceptics ([link](#))
- Nokia Bell Labs: Communications in the 6G Era Whitepaper, Sep 2020 ([link](#))
- Free 6G Training: One XR Device to Rule Them All!, Dec 2020 ([link](#))
- Qualcomm: Extended Reality ([link](#))
- Cognitive Times: Smart Shirts & Clothes Could Help Save Lives with Health Monitoring ([link](#))
- iDB: Future AirPods could track your heart rate and body temperature via built-in sensors ([link](#))
- IEEE Spectrum: Your Earbuds Will Become Your Most Powerful Health Monitor ([link](#))
- IEEE Spectrum: Treating Tinnitus Through the...Tongue? ([link](#))
- Elsevier – Nano Energy: Battery-free short-range self-powered wireless sensor network (SS-WSN) using TENG based direct sensory transmission (TDST) mechanism, Nov 2019 ([link](#))
- NTT Docomo white paper: 5G Evolution and 6G, January 2020 ([link](#))
- Ericsson: Ever-present intelligent communication - A research outlook towards 6G, Nov 2020 ([link](#))

Thank You

To learn more, visit:

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3G4G Blog – <https://blog.3g4g.co.uk/>

Telecoms Infrastructure Blog – <https://www.telecomsinfrastructure.com/>

Operator Watch Blog – <https://www.operatorwatch.com/>

Connectivity Technology Blog – <https://www.connectivity.technology/>

Free 5G Training – <https://www.free5gtraining.com/>

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