Cross-Industry Whitepaper Series: Empowering our connected world

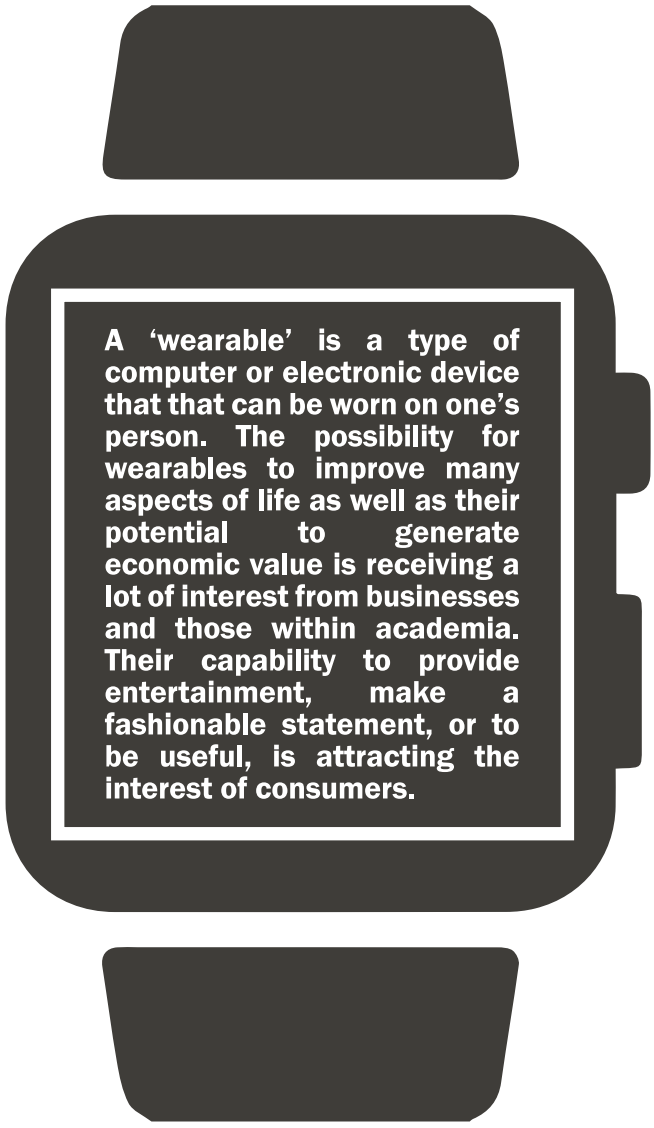
# SENSOR-ENRICHED HUMANS
# WERABLES START TO TRANSFORM PEOPLE AND THEIR LIVES

Key topics we will discuss in this paper include:

- Different types of wearables
- Benefits of broadband and LPWA networks
- Benefits of operators

HUAWEI

# INTRODUCTION




The wearables market has so far been dominated by watches and fitness and activity trackers that have only local connectivity. They are typically either wired or connected via Bluetooth or WiFi to a PC or a smart phone. Such “tethered” devices can provide wide-area connection only when used with a mobile device.

But these are only parts of a growing market that also encompasses a wide range of other wearables designed for both consumer, public and business applications – including more sophisticated health monitoring, and image, video and environmental data capture and upload / streaming.

Increasingly, wearable devices offer direct connectivity using cellular networks. As the coverage and performance of mobile networks improves, and they become better able to handle the connectivity needs of wearable devices of many kinds, tethering to a separate device will not be needed, and the wearables market will expand.

Analysts estimate between 100[1] million and 150[2] million wearables will be shipped worldwide in 2016, and shipment volumes are expected to rise quickly. According to IDC global shipments of wearables will reach nearly 214 million units in 2020.[3]

This growth in shipments will be reflected by a rise in wearables-related revenue. According to Scalar Market Research the whole global wearables market is predicted to increase from a value of US$28.89 billion in 2016 to US$71.23 Billion by 2021. The Asia-Pacific region is expected to be the fastest expanding market in that timescale although North America will remain the largest market in terms of revenues.[4]

This paper looks at the different types of wearables, and shows how they will make use of direct wide-area connections via mobile networks – for applications that need low data volumes sent infrequently, to those that need real-time streaming of videos.

1 - http://www.idc.com/getdoc.jsp?containerId=prUS41530816
2 - Excluding Bluetooth headsets: http://www.gartner.com/newsroom/id/3198018
3 - http://www.idc.com/getdoc.jsp?containerId=prUS41530816
4 - https://www.scalarmarketresearch.com/market-reports/wearable-technology-market

# KEY DATA

**214**
**MILLION UNITS**
of wearable technology will be shipped by 2020.

**71.23**
**BILLION DOLLARS**
the whole global wearables market is predicted to increase from a value of US$28.89 billion in 2016 to US$71.23 Billion by 2021

**25**
**MILLION UNITS**
of global sales in werable cameras

**111**
**MILLION UNITS**
rise in shipments of smartwatches globaly by 2020.

**9.3**
**BILLION DOLLARS**
expected market worth of smart clothing by 2024.

**4.5**
**BILLION DOLLARS**
in growth for the smart medical sensors market.

**13**
**BILLION DOLLARS**
expected growth for mobile operators in service revenues by 2020.

# WEARABLES FOR EVERY OCCASION

**Part 1**

**There are now many types of wearable available in the market, serving a wide variety of use cases. They can be grouped into several broad use types: video capture (e.g. for surveillance, live streaming, personal use); audio delivery; medical and wellness monitoring (in a clinical context); fitness tracking (in a consumer context); and provision of infotainment.**

**They also come in a variety of device types:**

- Watches
- Wristbands
- Cameras
- Earphones and Earbuds
- Smart fabrics and Smart clothes
- Medical Sensors

These types of wearable are considered in more detail below. Specialist AR/VR headsets could be considered as 'wearables' but are a quite different category of device. They are analysed specifically in a separate paper in this series, and not covered here.

## SMARTWATCHES

The largest sector in the wearables market is smartwatches. The first commercially successful smartwatch was released by Apple, kick-starting the growth of the market we can see today. These wrist wearable devices can be used to receive or make a call, text or social media update. They also offer access to increasing numbers of fitness, news, shopping, travel, radio and entertainment applications designed specifically for watches.

Most smartwatches feature smartphone connectivity through Bluetooth or WiFi connections, although 2016 has seen an increase in the number of cellular-connected watches, including devices from LG, Samsung[5], and a variety of smaller, specialist manufacturers[6]. An Android OS for smartwatches providing cellular connectivity (Android Wear 2.0) is due for launch in 2017. Developer previews are already available on Huawei and LG devices.[7]

The market for smartwatches is widely expected to continue to grow rapidly. Scalar Market Research predicts that the over the next 5 years the wearables market will continue to be dominated by smartwatches, and that this segment will grow at a rate of 15% per year[8]. Gartner expects watch shipments to rise to more than 111 million units globally by 2020[9].

## WRISTBANDS

Wrist bands are the second largest category of wearable devices. Focused on fitness applications (such as heart rate monitoring, GPS route tracking, or step counting), they have achieved widespread use. Fitbit, Xiaomi, Apple and Garmin between them hold more than half of the global market. These devices are typically tethered to a user's mobile phone.

## VIDEO CAMERAS

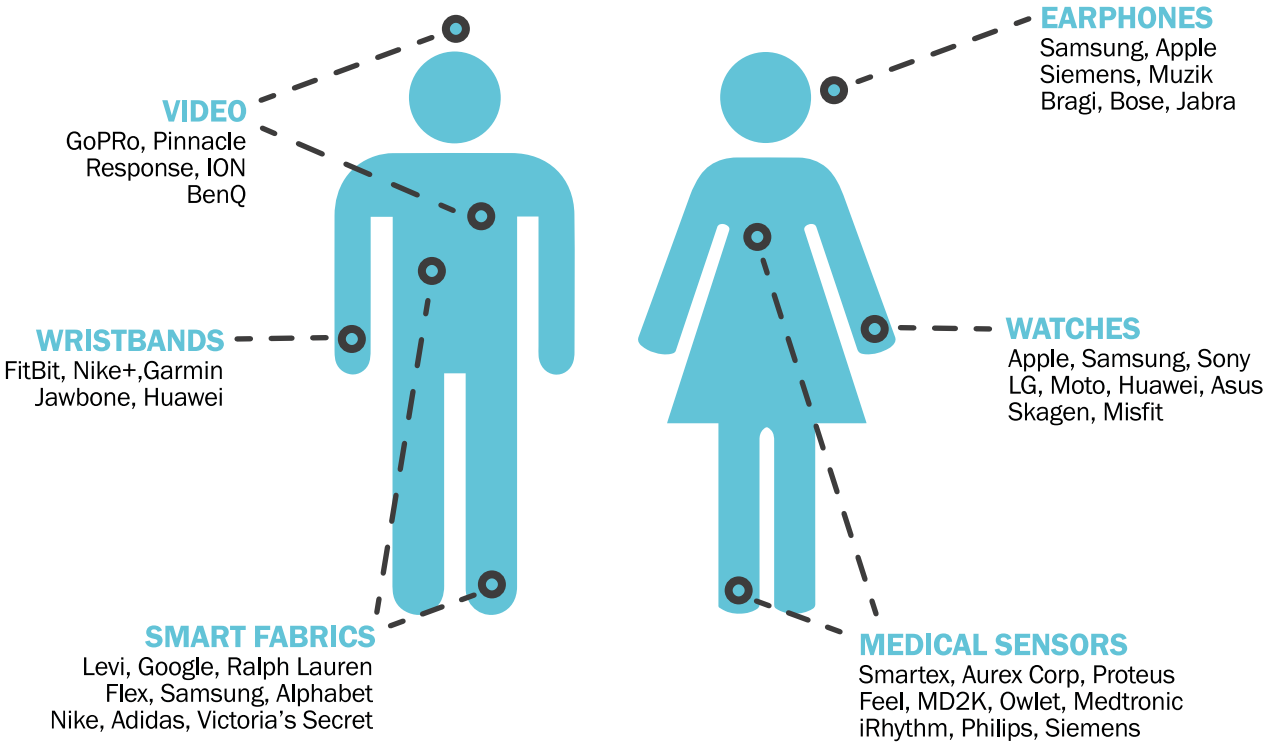
As people increasingly want to record and share their activities and adventures like scuba diving, snowboarding, bungee jumping etc. via social media, they are buying wearable cameras. This is a growing market. CCS Insight expects global sales of 25 million wearable cameras per year by 2020[10].

One of the leading brands in this field is GoPro. It recently released its new Hero 5 camera and has partnered with Red Bull, an extreme sport event sponsoring company. Most wearable cameras use local storage, although network connectivity is being introduced. For instance, the BenQ QC14G Action Camera is similar to the GoPro and is designed to be used in rough activity, but it includes 4G connectivity for live streaming of content.

5 - http://www.samsung.com/us/explore/gear-s2/
6 - For an example list, see http://vandrico.com/ wearables/device-categories/connectivity/cellular-network
7 - https://developer.android.com/wear/preview/program.html;
8 - https://www.scalarmarketresearch.com/market-reports/wearable-technology-market
9 - http://www.gartner.com/newsroom/id/3198018
10 - http://www.ccsinsight.com/press/company-news/2516-wearables-momentum-continues

# WEARABLES FOR EVERY OCCASION

**Part 2**




Wearable cameras are also appearing in areas such as law enforcement, and enterprise security. In the UK, for example, Pinnacle Response supplies police officers with chest mounted cameras that record their movements and interactions. It can store 8 hours of 1080p video and audio footage, has a 32GB SD card as memory and takes 2 hours to charge. Once the officers return to the station they upload the footage.

## EAR PHONES AND EAR BUDS

The wearable device market includes earphones, headphones and audio recording devices. Currently, the market is trying to diversify with products such as the Intelligent Headset, by Jabra, which integrates GPS, 3D audio, accelerometer, compass and gyroscope as well as phone connectivity allowing for use with interactive games and tour guide apps. Fitness tracking devices are also moving from the wrist and into the ear, one example is Chinese company WBD101 which won the GSMA GLOMO award 2016 for its ActivHearts earbuds. These can monitor heartrate even during exercise with wide app-compatibility and low power consumption. Wireless capabilities are increasingly common, but these sorts of devices typically use Bluetooth to connect to a user's mobile phone.

## SMART FABRICS / SMART CLOTHES

Smart fabrics and smart clothes are a new and growing part of the wearables industry. Grand View Research expects the smart textiles market to be worth USD 9.3 Billion by 2024[11]. This market has been made accessible by the increasing lightness, versatility and affordability of sensors and electronic circuits along with the growing penetration of smartphones using Bluetooth technology. American denim giant, Levi, is an example innovator. It has partnered with Google to create a jacket with integrated technology - by interacting with a button on the sleeve the wearer can play music, answer calls, pull up a list of nearby restaurants etc. Another is clothing brand Lyle & Scott which has released a contactless payment jacket using bPay by Barclaycard –wearers make payments by swiping their arms near the payment machine.

GOQii has created an ecosystem around its fitness trainers concept. Its GOQii tracker collects a user's fitness

11 - https://www.grandviewresearch.com/press-release/global-smart-textiles-industry

# WEARABLES FOR EVERY OCCASION

**Part 3**

trainers concept. Its GOQii tracker collects a user's fitness information, which is then sent to a group of coaches. They will give the user personalised diets and feedback on the user's fitness goals. The data is additionally sent to a doctor who can provide the user with medical options. The data can also be uploaded to the cloud, providing the user with a log of their medical reports and fitness information over a period of time.

## MEDICAL SENSORS

Medical sensors are a group of devices with considerable potential – they could be used to support diagnosis, therapy and rehabilitation for a wide variety of clinical conditions. They don't come in any single form or shape; the sensors are embedded in devices that are ergonomically designed to fit whatever part of the body needs monitoring. However, this group can be differentiated from all the other wearables by their purpose – to support someone's medical care. In this respect they have much higher reliability requirements.

In some cases, failure can have life threatening consequences. It is for this reason that wearables are not yet widely used within a clinical context. There are a great many wearable medical devices in use, but where these collect data, that data is typically logged offline by a medical professional. Wearable medical devices that use embedded (or tethered) wireless connections to automatically collect data, or to enable remote administration of medical care, hold great promise. There have been many trials around the world, but widespread usage within clinical environments will not occur until medical professionals have been convinced of their usefulness, reliability, accuracy, cost-effectiveness, and safety, and in some cases, only when regulation permits their usage.

Nonetheless market intelligence firm Global Industry Analysts forecasts that the market for medical wearables will grow to US$4.5 Billion by 2020[12]. The table below provides some illustrative examples of wearable medical sensors.

| COMPANY | PRODUCT DETAILS |
|---|---|
| **NEUROSKY** | ECG biosensor chipset which captures and translates ECG information. Can be embedded in other devices like watches. Also provides a cloud platform to support app creation. |
| **OWLET** | Uses pulse oximetry (blood oxygen saturation monitoring) sensors which are put into a sock for babies. Data is then sent to a base station via Bluetooth so that parents can monitor vitals on an app. |
| **BEBOP SENSORS** | Sensors which can be woven into fabric or non-fabric material and connect using Wi-Fi. They can be utilized for pressure sensitive items such as bedding, bandages and prosthetic interfaces. |
| **CELLNOVO** | Mobile diabetes management system, including an insulin patch pump, activity monitor, cellular-enabled wireless touchscreen handset with integrated blood glucose meter and automatic connectivity to secure servers. (The connection between the pump and the handset uses ANT). |
| **MD2K** | Easy Sense - a micro-radar sensor worn near the chest to measure heart activity and lung fluid volume. Developed by MD2K this streams data via Wi-Fi to a smartphone. |
| **FEEL** | Emotion Tracker. Wristband with sensors that measure a variety of biosignals (electrodermal activity, blood volume, and skin temperature), connects to an app which analyses the data and supports cognitive behaviour therapy. |
| **PROTEUS DIGITAL HEALTH** | Ingestible sensor and small wearable patch and a mobile app and provider portal. By taking the sensor in a pill the product is activated and sends a signal to the torso patch, the information received is then sent to a mobile, and then to the cloud platform where it is accessible to healthcare providers and caregivers. |
| **ORPYX MEDICAL TECHNOLOGIES** | Pressure sensors in shoes for diabetics to show if at risk of developing foot ulcers, with the aim of preventing peripheral nerve damage and amputations. Uses ANT to connect to a phone. |

12 - http://www.strategyr.com/pressMCP-7956.asp

# THE BENEFITS OF MOBILE BROADBAND AND LPWA NETWORKS FOR WEARABLES

**Most current in-car surveillance systems come equipped with a built-in DVR (digital video recorder) or storage card. For instance, the Cadillac CT6 includes seven cameras, four of which are hidden surveillance cameras fitted in the front grille, door-mounted rear view mirrors and the lid of the trunk. As well as filming journeys and offering a 360-degree display, they also record video when an alarmed car is tampered with, or record an incident. The Cadillac records evidence on an SD card in the trunk.**

**COVERAGE -** mobile networks offer near-ubiquitous coverage, including access to services outside buildings. This is not the case with hotspot-based connectivity solutions.

**MOBILITY –** The whole point of wearables is that they will go wherever the user will go. This means that hotspot approaches are only useful in very limited settings (e.g. for solutions in care homes and hospitals, where the users of the wearables will not leave the premises). People will also move quickly from one location to another. The network connection needs to support seamless transition from one network cell to another to match the user's movement.

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**USER DENSITY -** 3GPP-based mobile and LPWA networks, with their intended capabilities to cope with massive numbers of network users, and to cope with massive numbers of machine-type connections, will be able to support highly dense deployments of wearables. This will be critical in and around settings such as hospitals or in public areas where lots of people may come together.

**EASE OF USE –** Wearables with embedded connectivity are much easier to use. There is no need to work out how to tether a device, nor to worry about straying too far away from that tethering device, or from a WiFi hotspot (such that you are out of range). There is also no need to carry the tethering device (for instance when out running). Ease of use is a vital success factor for any consumer application, and for any medical wearable which must be looked after and used by a member of the public.

**PHYSICAL SECURITY -** Enabling a device to directly upload data to the cloud or to be streamed live, means there is less chance of data loss, theft or deliberate destruction, and hence enhances security. This is valuable for policing and security services.

**ECONOMIC BENEFITS -** in a public health setting, it may not be economical to provide a mobile phone to support tethering, and medical applications cannot rely on using a consumer's phone. An embedded mobile connection resolves these problems.

**ABILITY TO MAKE VOICE CALLS –** some types of wearable could be used to make voice calls if equipped with their own mobile network connection.

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**QUALITY OF SERVICE / RELIABILITY –** in the context of wearables provided for medical purposes quality of service and reliability will be critical. Future mobile networks will have the capability (through network slicing) to guarantee quality of service for specific medical and emergency service applications - if necessary at the expense of consumer services. Guaranteeing quality of service or reliability for wearables using hotspots for connectivity, or tethering to consumers' own phones is very much harder, as the medical organisation is not responsible for the device being used, and the network operator is very often not in control of the hotspot. This concept of control, has implications for service continuity, and security.

One issue that has to-date limited the use of mobile networks (and LPWA networks) in relation to wearables is power consumption. Very small wearables cannot support large batteries, and may need a relatively long battery life, even when communicating over long distances. However recent work within the 3GPP has been addressing this issue, and is making scale reduction possible.

**"Neul and Huawei are already working on 3GPP Release 14 updates to NB-IoT that will require even lower power, enable circular positioning and make modules smaller - these features will open up new opportunities particularly for wearables in the health and care sector"**

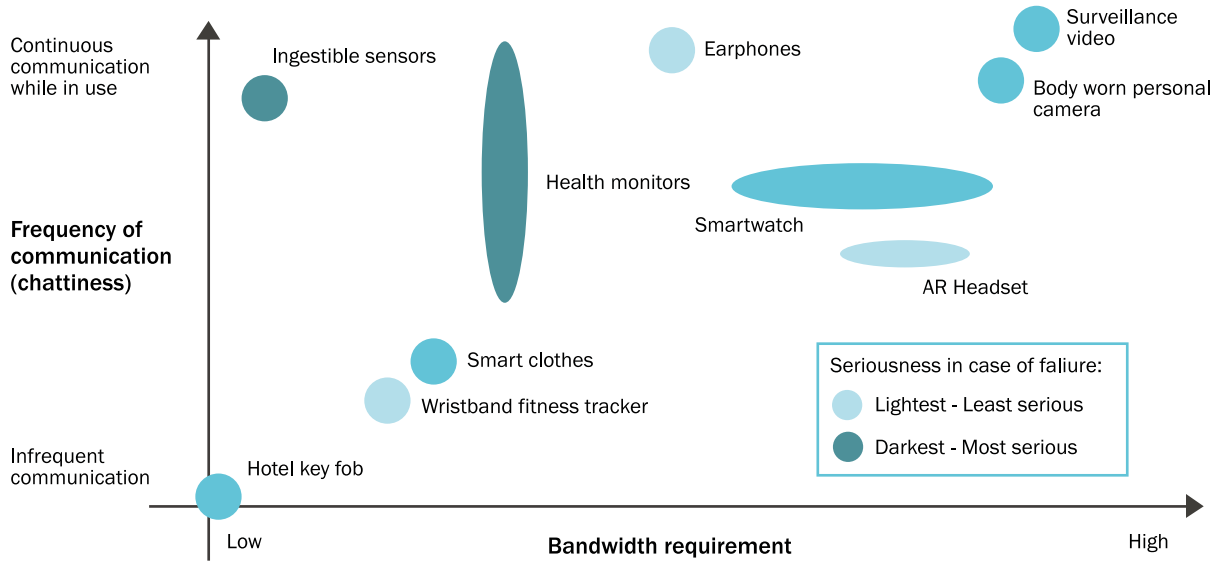
**- Luis Barreto,** Product Director, Neul

# BENEFITS FOR OPERATORS

**Mobile operators should be positioning their networks to provide services that can enhance the consumer and commercial appeal of wearable devices. They need to be aware that wearable devices all have different usage characteristics, such that some will benefit from access to LPWA infrastructure, and some will need access to 3G, 4G or 5G mobile networks. The key networking characteristics include:**

- **Bandwidth requirements: Will the device need high throughput to stream video, or will it only send small data packets?**
- **Frequency of communications: Will the devices be chatting all the time, or will they only communicate in bursts?**
- **Time sensitivity: Does the communication need to be delivered in real-time, or can it be time-delayed?**
- **Mobility requirements: Will the device need to move only within a local setting (such as a care home), or within a given area (such as a city), or anywhere in the country, or provide international services? Will it need to cope with rapid movement (e.g. in a car or train)?**
- **Battery requirements: Does the device need to operate for a long time, on little power?**

**THE CHART BELOW ILLUSTRATES HOW THE REQUIREMENTS OF WEARABLES VARY IN TERMS OF THEIR CHATTINESS AND BANDWIDTH REQUIREMENTS.**




There is a significant market opportunity available for operators that get their market positioning and networking strategy correct in relation to wearables. A recent study from Signals and Signals Telecom predicts that the wearables market could be worth as much as US$13 billion per year in service revenues for mobile operators by 2020[13].

13 - http://www.prnewswire.com/news-releases/wearable-technology-market—devices-revenue-of-13-billion-for-mobile-operators-by-2020-581787911.html

# KEY TAKEAWAYS

**01** Wearables are not a passing fad. The market for wearables is growing fast, with a variety of applications ranging from entertainment, to security, to fitness, to medical care. The market will continue to grow very rapidly in coming years.

**02** While early wearables have used short range technologies to provide connectivity (e.g. WiFi or Bluetooth tethering to a mobile phone), cellular connected devices have started to emerge on the market, often initially with integrated LTE connectivity.

**03** Mobile connectivity offers advantages over Wi-Fi or other hot spot connectivity solutions for the wearables market including: increased mobility, wide area network coverage, and ability to cope with high density usage.

**02** Direct-mobile connectivity for wearables offers several advantages over tethering including ease of use, potential economic benefit, and improved scope to control reliability and quality of service.

**03** Operators need to offer both LPWA and 3G,4G,5G connectivity options for wearables manufacturers; doing so will open up valuable new service markets.