

# Comparison of wired and wireless broadband technologies

	Down-Upstream Rate (technical standard max.)	Efficiency range (technical standard max.)	Infrastructure architecture	Suitability	Future of the technology
<b>Wired Broadband Technologies</b>					
<b>ADSL, ADSL2, ADSL2+</b>	24/3 Mbps	5 km	<ul style="list-style-type: none"> <li>internet access by transmitting digital data over the wires of a local telephone network copper line terminates at telephone exchange (ADSL) or street cabinet (VDSL)</li> <li>Vectoring: Elimination of cross talks for higher bandwidths</li> <li>G.Fast: Frequency increase up to 212 MHz to achieve higher bandwidth</li> </ul>	<ul style="list-style-type: none"> <li>use of existing telephone infrastructure</li> <li>fast to install</li> <li>small efficiency range due to the line resistance of copper connection lines</li> </ul>	<ul style="list-style-type: none"> <li>further speed and range improvements by enhancing and combining new DSL-based technologies (phantom mode, bonding, vectoring)</li> <li>bridge technology towards complete fibre optic cable infrastructure</li> </ul>
<b>VDSL, VDSL2, Vectoring</b>	100 /40 Mbps	1 km			
<b>G.Fast</b>	Gbps bandwidths possible	100 m			
<b>CATV</b>	200/100 Mbps	2-100 km	<ul style="list-style-type: none"> <li>coaxial cable in the streets and buildings; fibre at the feeder segments</li> <li>network extensions to provide backward channel functionality</li> </ul>	<ul style="list-style-type: none"> <li>use of existing cable television infrastructure</li> <li>fast to install</li> <li>high transmission rates</li> </ul>	<ul style="list-style-type: none"> <li>Further implementation of new standards (DOCSIS 3.1 &amp; 3.1 full) will allow to provide higher bandwidth to end-users</li> </ul>

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<b>Optical Fibre Cable</b>	10/10 Gbps (and more)	10-60 km	<ul style="list-style-type: none"> <li>• signal transmission via fibre</li> <li>• distribution of signals by electrically powered network equipment or unpowered optical splitters</li> </ul>	<ul style="list-style-type: none"> <li>• highest bandwidth capacities</li> <li>• high efficiency range</li> <li>• high investment costs</li> <li>• bandwidth depends on the transformation of the optical into electronic signals at the curb (FTTC), building (FTTB) or home (FTTH)</li> </ul>	<ul style="list-style-type: none"> <li>• next generation technology to meet future bandwidth demands</li> </ul>
<b>Wireless Broadband Technologies</b>					
<b>LTE (Advanced) (4G)</b>	100/30 (1000/30) Mbps	3-6 km	<ul style="list-style-type: none"> <li>• mobile devices send and receive radio signals with any number of cell site base stations fitted with microwave antennas</li> <li>• sites connected to a cabled communication network and switching system</li> </ul>	<ul style="list-style-type: none"> <li>• highly suitable for coverage of remote areas (esp. 800 MHz)</li> <li>• quickly and easily implementable</li> <li>• shared medium</li> <li>• limited frequencies</li> </ul>	<ul style="list-style-type: none"> <li>• commercial deployment of new standards with additional features (HSPA+,5G) and provision of more frequency spectrum blocks (490 - 700 MHz)</li> <li>• meets future needs of mobility and bandwidth accessing NGA-Services</li> </ul>
<b>HSPA / HSPA+ (3G)</b>	42,2 / 5,76 Mbps / 337 Mbps / 34 Mbps	3 km			
<b>5G</b>	10/20 Gbps	3-6 km		<ul style="list-style-type: none"> <li>• high achievable data rates</li> <li>• low latency</li> <li>• high reliability</li> <li>• higher frequency bands</li> <li>• advanced multi-antenna transmission</li> </ul>	<ul style="list-style-type: none"> <li>• meets future needs of mobility and bandwidth accessing NGA-services</li> </ul>

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			<ul style="list-style-type: none"> <li>mobile devices send and receive radio signals with any number of cell site base stations fitted with microwave antennas</li> <li>sites connected to a cabled communication network and switching system</li> </ul>	<ul style="list-style-type: none"> <li>handling of extreme device densities</li> <li>flexible spectrum usage</li> </ul>	<ul style="list-style-type: none"> <li>enables connectivity for a wide range of new applications</li> </ul>
<b>Satellite</b>	30/10 Mbps	High	<ul style="list-style-type: none"> <li>mobile devices send and receive radio signals with any number of cell site base stations fitted with microwave antennas</li> <li>sites connected to a cabled communication network and switching system</li> </ul>	<ul style="list-style-type: none"> <li>highly suitable for coverage of remote areas</li> <li>quickly and easily implementable</li> <li>run time latency</li> <li>asymmetrically</li> </ul>	<ul style="list-style-type: none"> <li>30 Mbps by 2020 based on next generation of high-throughput satellites</li> </ul>
<b>LEO Satellites</b>	Signal distribution to user via WIFI/LTE/HSPA		<ul style="list-style-type: none"> <li>mobile devices send and receive radio signals with any number of cell site base stations fitted with microwave antennas</li> <li>sites connected to a cabled communication network and switching system</li> </ul>	<ul style="list-style-type: none"> <li>reduced latency</li> <li>affordable internet access possible</li> <li>controlling by the necessary ground stations of non-stationary flying satellites is very challenging</li> </ul>	<ul style="list-style-type: none"> <li>internet service for very rural and remote areas possible</li> </ul>
<b>INTERNET Balloons</b>	Signal distribution to user via WiFi/LTE/HSPA		<ul style="list-style-type: none"> <li>mobile devices send and receive radio signals with any number of cell site base stations fitted with microwave antennas</li> <li>sites connected to a cabled communication network and switching system</li> </ul>	<ul style="list-style-type: none"> <li>currently in a testing phase</li> <li>challenging controlling</li> <li>controlling by the necessary ground stations of non-stationary flying balloons is very challenging</li> </ul>	<ul style="list-style-type: none"> <li>internet service for very rural and remote areas possible</li> </ul>

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<b>Wi-Fi (802.11n)</b>  <b>(IEEE 802.11ad)</b>	600/600 Mbps  (7 Gbps)	200 m  (10 m)	<ul style="list-style-type: none"> <li>mobile devices send and receive radio signals with any number of cell site base stations fitted with microwave antennas</li> <li>sites connected to a cabled communication network and switching system</li> </ul>	<ul style="list-style-type: none"> <li>inexpensive and proven</li> <li>quickly and easily implementable</li> <li>small efficiency range</li> <li>shared medium</li> </ul>	<ul style="list-style-type: none"> <li>increased use of hotspots at central places</li> </ul>
<b>WiMAX (IEEE802.16e)</b>	6/4 Mbps (70 Mbps)	60 km			<ul style="list-style-type: none"> <li>gets continually replaced by Wi-Fi and LTE and plays therefore no significant role anymore; further developments are therefore not expected</li> </ul>
<b>Lifi</b>	max. 224 Gbps	several meters		<ul style="list-style-type: none"> <li>only delivers communication over short ranges</li> <li>low reliability</li> <li>high installation costs</li> <li>cheaper than Wi-Fi</li> <li>only effective and permanent within closed rooms</li> </ul>	<ul style="list-style-type: none"> <li>useful in electromagnetic sensitive areas such as in aircraft cabins, hospitals and nuclear power plants without causing electromagnetic interference</li> </ul>