Caburn Connect

The Benefits of Multi-Network Connectivity and Subscriber Identity Modules (SIMs)

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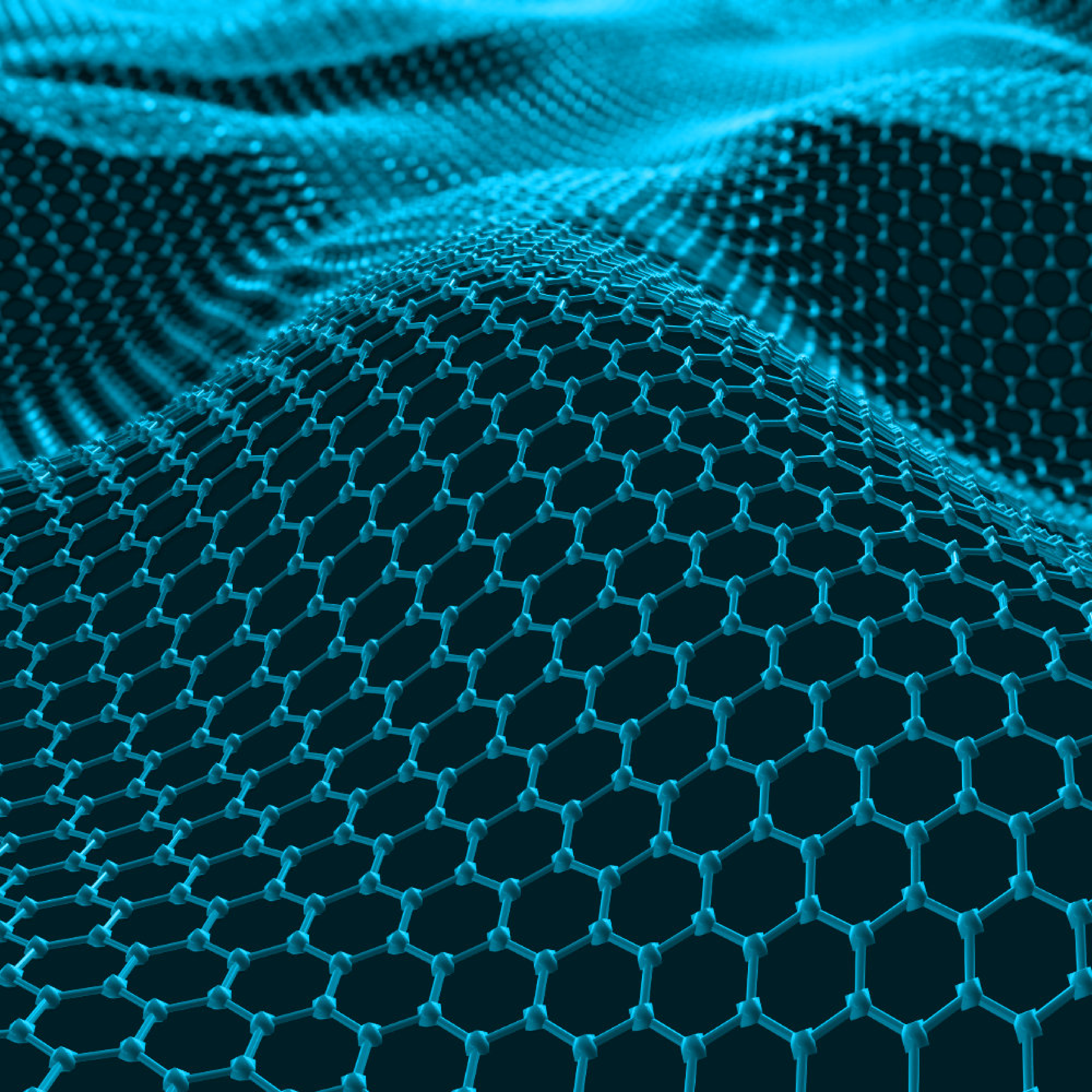
Introduction:

IoT devices can offer a range of valuable public and commercial services but require secure and resilient connectivity to operate beneficially and profitably. Multi-network systems provide substantial benefits for IoT service providers, provided they are carefully managed. Their benefits and pitfalls are discussed in this paper.



Motivations for using multi-network connectivity are typically; i) to enlarge geographical coverage, ii) increase service up-time, iii) ensure resilient and cost-effective cross-border roaming, iv) avoid local, regional, national or international service outages on a single network, v) enable management of connectivity beyond the retail services major individual networks provide (whose limited support is geared towards consumer mobile users or the very-largest corporate accounts).

Consumer mobile phones typically remain connected to one network. By employing commercial roaming agreements and investing in interfacing systems and technologies, however, Mobile Virtual Network Operators (MVNO’s) can deliver multinetwork capability for IoT devices. Allowing them to connect to the most favourable network based upon their local, physical, geographical, or temporal circumstances. Using the existing GSM mobile network infrastructure in this way, underpins many key public and commercial IoT services. Providing the ubiquitous access needed for those devices.

These devices, however, need to be able to authenticate themselves on the various mobile networks and their location registers. A managed SIM with robust connectivity plans will, therefore, enable its associated IoT device to connect to multiple networks, providing resilience, flexibility, and service performance. As IoT devices are released and move or travel, the ability to connect to the widest variety of mobile networks in a region or across borders, ensures services are not interrupted, while avoiding unexpected out of zone penalties. In mobile environments, such multi-network capability helps increase overall capacity and improves data rates (Zhang, et al., 2018).

Each individual network's extent of mobile coverage remains contentious (Fida & Marina, 2018). Coverage maps are usually provided by Mobile Network Operators (MNO's) themselves (Jarvis, et al., 2018) or via crowdsourcing mechanisms (Marina, et al., 2015). Coverage can be patchy, however, and newer technologies are usually deployed based upon likely returns on investment or economic factors. Meaning rural or poorer areas are usually less well served (Koutroumpis & Leiponen, 2016; Perlman & Wechsler, 2019). Service voids remain and local availability of 2G, 3G, 4G and 5G operational infrastructures vary (Alay, et al., 2020).

Indeed, coverage maps tend not to objectively reflect the operational experience of users (Jarvis, et al., 2018). Crowdsourcing data also conflates indoor and outdoor measurements and does not reflect device charactaristics, handling or limitations (Marina, et al., 2015). Confusing the significant effects that buildings and structures have on reducing signal strength (ibid). Similarly, the impact of attenuation, poor weather, radio-shadows, operational voids, weak-signals and temporal variations tend not to be considered (Fida & Marina, 2018).

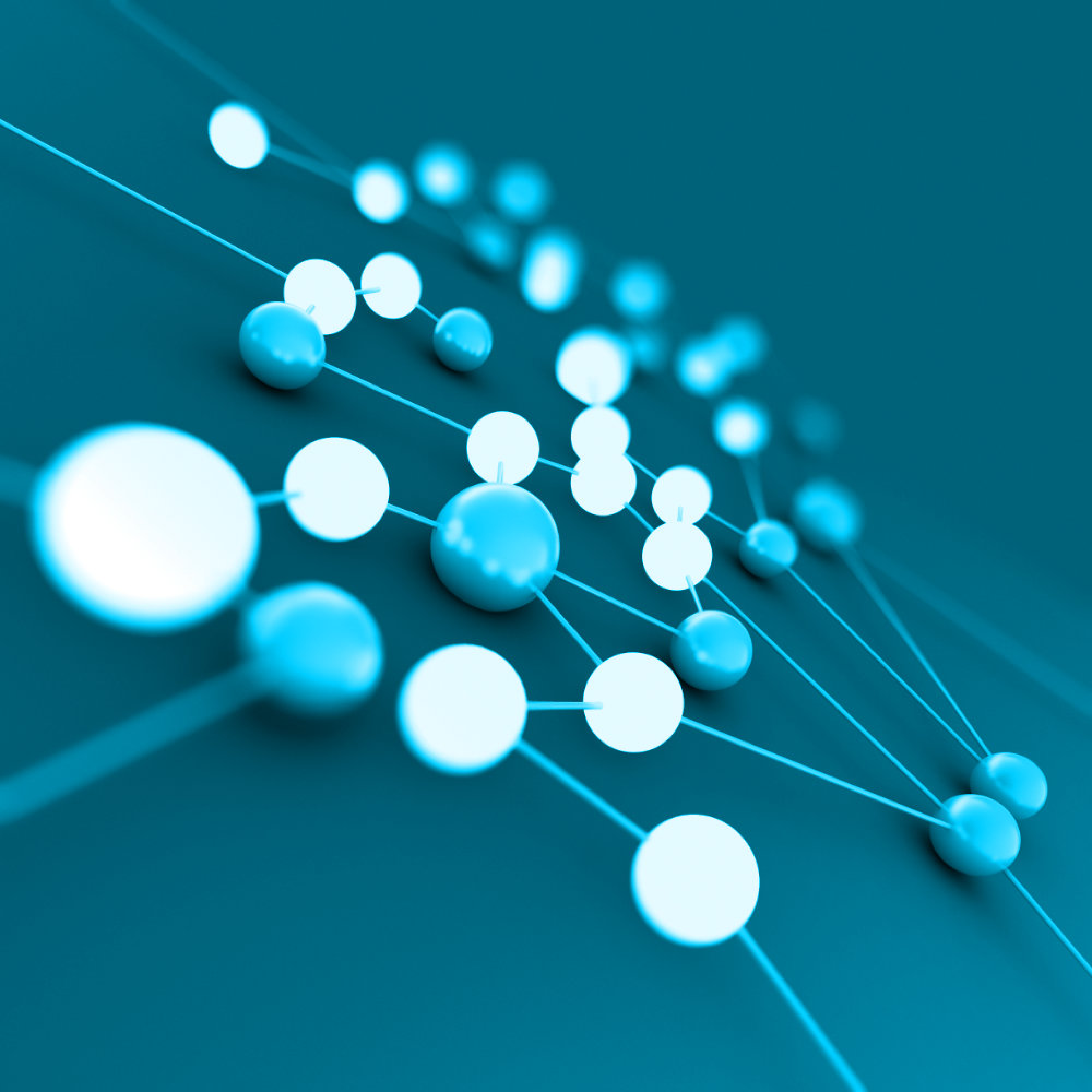
Device connectivity also depends upon a dynamic range of local and core-network system interactions, which affect performance and service levels (Alay, et al., 2020). For these reasons, and due to the nature and complexity of mobile networks, it is recommended that actual user experiences (client-assisted-data) forms part of the measurements (Sen, et al., 2011). Being continuously monitored to factor in environmental, temporal, and contextual changes (ibid).

These practical problems mean experienced IoT service providers typically extend geographical and temporal service levels via a multi-network approach. In the consumer and business markets, the main mobile network operators are competing, making neutral cross-relationships unworkable. Multi-network providers such as Caburn Solutions, however, work to deliver a structure that permits devices to select and communicate with the best network available. This is achieved by producing a SIM that is accepted by each of the MNO's via long-term agreements. A high-quality multi-network provider ensures these roaming agreements reflect the type of devices and their expected connectivity profiles.

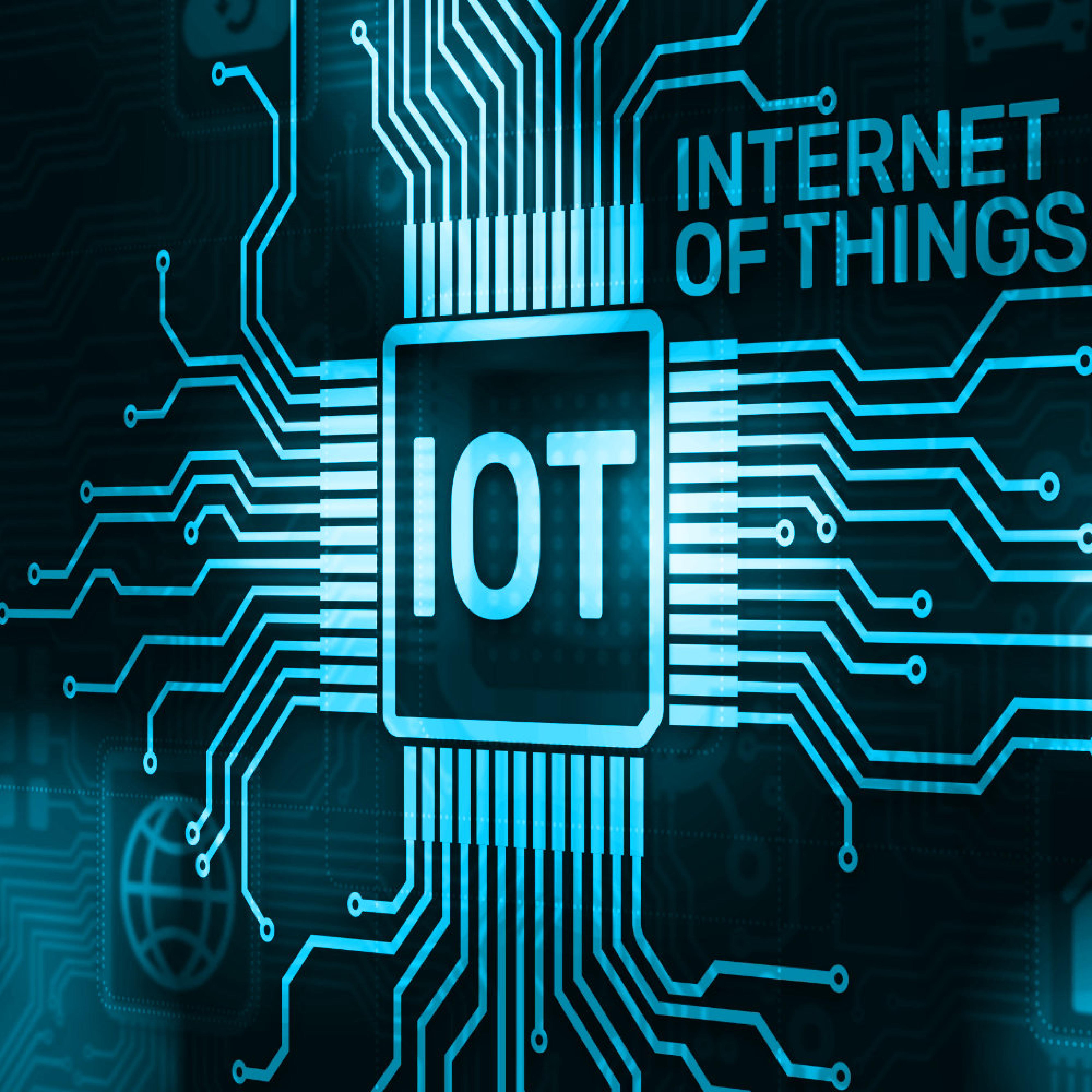
For example, while early M2M devices and their traffic tended to involve small data packets, increasingly devices require human interaction or provide some level of service experience for the user. Beit voice quality, latency, speed of service, privacy, or security. Increasingly, much broader use applications recognise the benefits of multi-network connectivity and seek to integrate them into wider service offerings.


HIGH VOLTAGE

Mission critical services for vehicle telematics, insurance, lone-workers, tele-health, telecare, assisted-living, epos terminals, hot-spots, routers, personal security devices, CCTV, bodycams, asset security and management systems all rely on multinetwork connectivity. In these sorts of user and device interactions, it is important to consider not only quality of service, but also quality of experience (Alay, et al., 2020).



Mobile systems are convoluted and when combined form complex ecosystems (Alay, et al., 2020). Ubiquitous access depends not only upon the specialised SIM variant, but also the devices compatibility with; the various radio frequencies and the variety of network evolutions supported by each network (Fida & Marina, 2018). For example, approved modems, the access technologies available and each network provider(s) regional and national implementation and disposal of 2G, 3G, 4G and 5G infrastructure (Alay, et al., 2020).


INTERNET
OF THINGS
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Multi-network characteristics of devices are also affected by the capabilities of the IoT device itself (Fida & Marina, 2018). Vast arrays of devices have different levels of network intelligence or selection logic. Some are battery powered and others connected to the mains supply. Remaining connected to the network, or the need to close connections in sleep and hibernation modes to conserve battery life will therefore vary by circumstance.

Some will have simple network selection algorithms based upon signal strength, while others will have more astute selection procedures. For example, the firmware can be designed to select networks manually or automatically. More intelligent devices can use network evaluation steps/algorithms for selecting the best network to connect with. While the most primitive devices will select based upon strongest signal only, irrespective of bandwidth or services available, others can select based upon the availability of the required services, unique communication requirements, or will ping certain data services to first measure end-to-end data connectivity.

For instance, selecting network based simply on signal strength may mean that a 2G or 3G network is selected, when a slightly lower strength 4G one is available. This may not matter for those applications requiring a simple voice connection, but for those needing data only, it can severely impact service or performance.

This device capability is also important as devices may need to intelligently select or switch networks in certain circumstances. i.e.; i) if the local strongest measured signal by the device is 2G, but data connectivity is required; ii) One of the MNO’s suffers core network issues, which to the device appears that a network is available when end to end connectivity on that network is not possible; and iii) other contextual or temporal factors meaning the loss of a radio connection or time-outs, which the device will need to have processes in place to manage. Network selection criteria becomes especially important when there is congestion on one of the networks, or an outage.

This is crucial as a catastrophic failure on an individual MNO core-network could result in hours of down-time on that network, while investigation, rectification and recovery works are implemented. This can sometimes involve load balancing and management of traffic congestion through points of failure or constriction. The ability to select another network in this scenario is invaluable. Eliminating such periods, where none of the population of IoT devices can communicate for an extended period.


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Selecting the right connectivity and SIM partner is therefore critical, not only in helping choose, configure, and optimise device's connectivity, but also to provide real time advice and support should any of the MNO's networks or devices suffer issues. Indeed, some compatibility issues may require more involved investigations. This is where a partner with high levels of telecom network expertise and resourced support structures is invaluable.

Close relationships with our customers and partners also ensure that Caburn constantly monitors and tests networks; often advising MNO problems to our clients in advance of the networks detecting problems themselves. Caburn's large client network also helps us to continuously monitor service levels and user experiences. Forming a responsive and far reaching mobile ecosystem (Sen, et al., 2011) for establishing high levels of quality of service and user experiences.

The right connectivity partner can also help future-proof roll outs. This is achieved by advising in good time of network features, upgrades, or sunsets. Safeguarding technologies which match the desired evolution and lifespan of devices is important, as the costs of a retrofit of dispersed devices is viewed as a failure of foresight. A high-quality connectivity partner also ensures communication plans and agreements match use cases.

MNO's dislike their networks being infiltrated by undisclosed M2M device signalling and closely monitor these situations. Spotting SIM profiles not in-line with their connectivity plans and pre-agreed commercial arrangements, means they may unilaterally apply extra surcharges for those groups of devices, or permanently block those ranges of SIM's. A high-quality provider, therefore, also invests in optimising and upgrading their networks and works closely with MNO's to create strong, mutually beneficial relationships.

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