White Paper

Reliable 60 GHz Radios Facilitate Last-Mile Gigabit Connectivity for Telco & Non-Telco Organizations

Contents

1. Executive Summary

Millimeter wave (mmWave) wireless technology at 60 GHz has reached maturity, both technically and commercially. This technology offers a number of significant features, which enable Gigabit+ speeds for a large variety of applications including fiber-like connectivity at short distances.

The 60 GHz band requires no licensing fees or effort in a large number of countries, thus providing the potential to minimize CapEx & OpEx but also raising some reliability concerns.

This paper summarizes the characteristics and potential use cases of 60 GHz wireless technology, while discussing the advantages and concerns for its adoption by all types of organizations, with particular focus on those lacking experience with wireless transport systems.

Both Mobile Network Operators (MNOs) and organizations – such as wireline operators / ISPs, large industries & utility companies, public authorities and service providers , higher education & health institutions and ad-hoc network providers – can greatly benefit from the adoption of 60 GHz wireless transport technology.

2. Challenges of Gigabit Connectivity

Today, a broad range of organizations are in search of Gigabit connectivity solutions that are cost-effective, easy to deploy and operate, flexible and future-proof. The option to deploy fiber is in many occasions cost-prohibitive and slow in implementation.

Alternatively, the deployment of more-than-one microwave (MW) links working in parallel may fulfill the capacity requirements, but it does not satisfy the need for very low CapEx & OpEx in the new ubiquitous-broadband era. The high recurring costs and delays, imposed by the licensing procedures for current MW systems, further exacerbate the cost impact on wireless transport deployment business plans. These issues affect all operators and organizations.

Furthermore, organizations without prior experience in wireless systems encounter additional challenges regarding the adoption of such systems due to the lack of resources/experience in the areas of planning, licensing, deployment and operation.

mmWave technology comes to provide a solution for all the aforementioned problems. The mmWave radiation spectrum, lying in the 30 GHz to 300 GHz frequencies, corresponds to an electromagnetic wave wavelength in the range of millimeters (between 10 mm and 1 mm), hence the naming of the spectrum. Nevertheless, the wireless radio industry uses the term “millimeter wave” to describe frequencies over 55 GHz.

Currently, the most mature implementations of mmWave radios operate in the E-Band (71-76 / 81-86 GHz) and V-Band (57-66 GHz) frequencies. The importance of these spectral areas lies in their large size, which allows the use of large communication channel bandwidths, ranging from hundreds of MHz to more than 1 GHz. Mobile broadband network operators around the world are now pipelining the introduction of 60 GHz systems for their small-cell backhaul needs, as well as, provision of ultra-broadband access to enterprises.

3. Key Features & Benefits of V-Band Radio Systems

The systems operating in the 60 GHz spectrum are characterized by features, which make them attractive to all organizations and particularly to those not having prior experience in wireless systems. These features include:

- Very High Link Capacity
  The use of very wide channels allows achieving link capacities in excess of 1 Gbit/s in a cost-effective manner, using simple 1+0 link configurations and unsophisticated modulation formats. Such capacities are difficult to obtain at low cost by conventional MW systems (6 to 38 GHz) operating on channels with 56 MHz maximum possible bandwidths.

- Small-Size Equipment
  Operation at high frequencies corresponds to small wavelengths. Thus, small waveguides and small high-gain antennas can be manufactured. The small size and weight of 60 GHz radios allow fast and easy installation in any location, while minimizing the visual impact especially in urban environments.

- Short Range, High Deployment Density
  Due to the high frequency of the electromagnetic wave and the increased propagation losses from atmospheric oxygen absorption in the 60 GHz spectral area, the range of such links is restricted to a few hundred meters. The utilization of narrow-beamwidth antennas (combining small range and high gain) enables high frequency reuse and gives the opportunity to deploy links in proximity, without causing significant interference to each other.

4. Regulation for V-Band

The operation within the frequency range between 57 GHz and 66 GHz has already been addressed by international and many national regulators. The 57 GHz to 64 GHz band is allocated to Fixed Service (FS) on a worldwide primary basis. In particular, and in conjunction to the adjacent 64 GHz to 66 GHz frequencies, the 57 GHz to 64 GHz band is considered to be very suitable for short distances (up to 500 m) and high-capacity links deployed in dense scenarios.

Furthermore, the V-Band has been chosen for the development of next-generation, ultra-high capacity unlicensed WiFi access system called WiGig, which enables Gigabit+ download speeds.

The physical propagation features and the high antenna gains achieved in these frequencies make possible a lighter licensing regime than what is common for FS MW systems, which may include access to spectrum through the use of flexible frequency arrangements. The choice of the assignment method and actual frequency range used remains a decision for the national administrations.

Currently, there is a large variety of regulatory licensing approaches in every country: unlicensed, lightly licensed and fully licensed. Despite the regulatory treatment variety of V-Band by the national regulators worldwide, it is now a fact that in most countries, where this band is open for commercial use, part, or all the 57-64 GHz spectrum is offered free of license fees. This is advantageous in terms of elimination of the recurring operating cost for licenses, as well as, the delays and cost associated with the licensing procedure itself.

5. Applications for V-Band Radios

The adoption of V-Band radio technology by the MNOs, for the purpose of 4G/4G+ small-cell backhaul, is expected to be instrumental to the delivery of the converged ubiquitous broadband service in the short-to-medium term. However, attention should also be drawn to organizations that, in contrast to MNOs, do not have experience with wireless systems. Such organizations may benefit from the cost-effective and hassle-free high-capacity connectivity that V-Band technology is capable to offer, and include:

- Wireline Operators / ISPs
  V-Band radios can be used to offer a range of services to wireless or wireline / fixed-line operators or ISPs: from carrying out fiber extension and backhauling of DSLAMs to providing direct ultra-high-bandwidth, access-side connectivity. For example, Gigabit 60 GHz radios can be used as the last "half-mile" broadband connections from a fiber distribution point to the buildings of enterprises or other large organizations requiring ultra-broadband service. Additionally, Gigabit capacity distribution networks of complex topologies, made out of 60 GHz radios, can be used to provide reliable ultra-broadband access service to suburban residential areas.

- Large Industries & Utility Companies
  Large industrial facilities (manufacturing, mining), electricity and water companies can deploy V-Band radios in their plant sites, storage depots, distribution stations and office locations to backhaul security / surveillance HD cameras to the monitoring stations and/or create Gigabit LANs among their buildings, enhancing productivity and data storage / security.

- Public Authorities & Services
  V-Band radios can be used to interconnect public buildings in municipal areas or small towns/villages: city halls, police headquarters, schools and fire brigade buildings can converge on the same high-speed network infrastructure to enhance governance efficiency.

- Higher Education & Health Institutions
  University campuses and hospitals with multi-building sites can take advantage of V-Band radios to cost-effectively and rapidly deploy Gigabit-bandwidth links among the buildings (administration, database locations, teaching facilities, laboratories, clinics, libraries, etc.) to enhance and consolidate their ICT infrastructure and enable effective information management.

- Ad-hoc Networks
  Temporary networks may be set up in large construction sites, locations of natural disasters, refugee camps, outdoor sport event locations, etc.

In all the above environments, V-Band radios can also be used to backhaul WiFi access points, enabling cost-effective ubiquitous broadband connectivity and public access to information and web-based applications.

6. Facilitating Adoption of 60 GHz Radios by Organizations Lacking Relevant Experience

Usually, many organizations, like those listed in the preceding chapter, do not employ personnel that can handle planning, licensing, installation and operation / maintenance of wireless transport systems. These organizations are usually manned with IT or telco staff familiar with Ethernet/IP switching equipment, WiFi access points and their integration to the enterprise's LAN. Therefore, in order to overcome the very significant lack of expertise and operational capabilities barrier, and also to allow introduction into the networks of such organizations, V-Band radio equipment should be designed to offer a set of automations. These will simplify and speed up operations, which are associated with the lifecycle of the radio equipment: from design to deployment to monitoring and maintenance.

The small size and weight, and the smart design of such radios is a must in order to facilitate their installation on lightweight poles and/or walls, even by non-experts, without the use of specialized (i.e. expensive) lifting rigs or tools.

Deploying V-Band radio links of short range (i.e. of a few hundred meters) is relatively easier compared to the deployment of multi-km MW links, however, it may still challenge the non-experts of non-wireless telco organizations.

As it has already been mentioned, such radios have narrow-beamwidth antennas, which will hinder technicians unfamiliar with wireless systems from achieving the correct alignment required for optimum link performance, and will certainly increase the deployment time in any case. Using auto–alignment capable V-Band radios can lift the onus of the critical link alignment process and expedite the deployment of the links by non-expert technicians.

Radio parameter configuration and service provisioning automation are also highly-ranked features, which enable quick and easy parameterization of the equipment and speed up the deployment operations while minimizing potential errors.

Communications in the organizations are based on links and extended LANs, which require Gigabit speeds. High capacity enables low latency communication, which is practical for the transfer of multimedia traffic and large files to/from the data storage locations. Gigabit speed also gives the opportunity to deploy high-capacity protected rings, which can practically aggregate the traffic of multiple HD cameras. Today, V-Band radio equipment needs to be capable of such high throughputs to provide plenty of bandwidth and satisfy all these connectivity requirements.

Being equipped with multiple Ethernet ports and integrated switch functionality on the V-Band radio unit facilitates the interconnection of radios toward the forming of various network topologies, while providing add-drop features without the use of external devices. The capability to form protected rings, requiring bi-directionally symmetrical capacity, is crucial in cases where increased reliability is needed. V-Band radios, supporting standardized fast ring protection mechanisms (such as ITU-T G.8032 Ethernet Protection Ring), allow the deployment of wireless-only or combined wireless /wireline rings. Gigabit capacity opens up the possibility to use radios in applications such as mixed fiber-wireless rings for enhanced reliability, with the V-Band radio chain acting as fiber route backup.

The operation in an unlicensed band has the already-mentioned advantages but may raise questions on whether data transmission is reliable. In fact, V-Band systems can offer reliable connectivity by taking advantage of their capabilities and by employing intelligent features. Firstly, the very short range minimizes adjacent link

interference. Secondly, the narrow antenna beamwidth (less than four degrees FWHM) also minimizes off-link-axis interference. Furthermore, additional measures can enhance the reliability of V-Band radio links. These may include the automatic channel scanning and interference detection, a feature that expedites the deployment and enables flexible management of potential cases of interference during operation. The radio system should be able to perform automatic channel scanning and identify good quality frequency channels for operation without requiring additional expensive interference-detecting devices. This is useful at any time throughout the link deployment lifecycle, during installation or during the normal operation of the link. Transmission quality should be continuously monitored and in case of interference, an alarm should notify the operator. The automatic channel scanning process could be repeated in order to find a more suitable channel.

7. The StreetNode™ V60-PTP Complete V-Band Radio Solution

StreetNode™ V60-PTP is an innovative auto-aligning V-Band radio, which is part of the company's V60 PTP series. Designed and manufactured in house, StreetNode™ V60-PTP combines all the necessary features to enable easy integration with networks of any kind. This compact, all-outdoor radio operates in the 57-64 GHz spectrum and offers user throughputs well in excess of 1 Gbit/s.

When activating Packet Header Suppression, throughput can reach up to an industry-leading 1.7 Gbit/s (full duplex) for 64-Byte packets and 1.3 Gbit/s (full-duplex) for 1518-Byte packets. For link 99.99% availability, StreetNode™ V60-PTP offers its maximum capacity for a link range of up to 300 m and in excess of 300 Mbit/s for a link range of up to 600 m.

Furthermore, with its embedded Carrier Ethernet switch and three Gigabit Ethernet interfaces per radio unit, StreetNode™ V60-PTP offers advanced networking capabilities to deliver standardized Carrier Ethernet services, as well as, maximum deployment flexibility.

Several radio units can be interconnected to form relay and add-drop configurations, thus allowing easy implementation of "chain", "tree" and "ring" network topologies without the need for external switch devices. The high, bi-directionally-symmetrical capacity of StreetNode™ V60-PTP is ideal for ring implementations. Standards-based ITU-T G.8032v2 Ethernet Ring Protection (ERP) is supported by all the interfaces of the radio units, enabling rings with sub-50 ms protection switching.

For the stringent timing requirements of Mobile Network Backhaul, StreetNode™ V60-PTP offers a full range of packet synchronization options, including Synchronous Ethernet and IEEE 1588v2 TC and BC.

StreetNode™ V60-PTP offers a unique mix of innovations and operational features that minimize the time, complexity and cost of deployment, also providing safeguarding against deployment errors and potential interference threats. These unique features (and their benefits) are listed below:

Feature	Benefit
Auto-alignment	The installed units are activated and aligned automatically saving time and avoiding errors.
Zero-touch Provisioning using Off-the-Shelf Android Tablet	The equipment configuration files can be uploaded from a tablet via Bluetooth, simplifying and speeding up commissioning and service provisioning.
Intelligent Frequency Scanning	Aligned units can perform a scan for interference levels in the available channels. As a result, the best channel may be selected or future troubleshooting may be carried out. StreetNode™ V60-PTP continuously monitors transmission quality; if interference is detected, then an alarm is forwarded to the monitoring console. Then, the automatic channel scanning process may be initiated to identify a better-quality channel.
Direct AC Powering (while still offering direct DC and PoE options)	The capability to be powered directly from existing AC power outlets obviates the need and cost of using fault-prone, proprietary and expensive PoE adaptors, while increasing the reliability of the deployment in non-telco environments.

Benefits for the organization adopting StreetNode™ V60-PTP can be multi-fold: less deployment time, fewer and less-specialized technicians and avoidance of errors.

Despite the obvious CapEx & OpEx savings, the fact is that StreetNode™ V60-PTP can easily be introduced to organizations having no prior experience or expertise in wireless systems.

StreetNode™ V60-PTP can be managed through its integrated Bluetooth interface, by standard LCT, by a standard Web-browser through its embedded Web-Server and by uniMS™, the unified management suite from Intracom Telecom. Apart from offering full FCPS functionality, the TMN-based uniMS™ enables a multitude of automation, analysis and visualization tools, which allow users to monitor and manage the network equipment features and information irrespectively of the size of the network.

8. Glossary

AC	Alternating Current
BC	Boundary Clock
CapEx	Capital Expenditures
DSLAM	Digital Subscriber Line Access Multiplexer
ERP	Ethernet Ring Protection
FCPS	Fault Configuration Performance Security
FS	Fixed Service
FWHM	Full Width (between) Half Maximum
HD	High Definition
ICT	Information & Communications Technology
ISP	Internet Service Provider
IT	Information Technology
LAN	Local Area Network
LCT	Local Craft Terminal
MNO	Mobile Network Operators
MW	MicroWave
OpEx	Operating Expenditures
PoE	Power over Ethernet
PTP	Point-To-Point
TMN	Telecommunications Management Network
TC	Transparent Clock

www.intracom-telecom.com

Intracom Telecom Regional Contacts

Europe
19.7 km. Markopoulou Ave.
19002 Peania, Athens
Greece
t: +30 2106671000
f: +30 2106671001
sales@intracom-telecom.com

Russia & CIS
16 Krasnoproletarskaya Str.
Bldg. 1, Entr. 3, Moscow, 127473
Russia
t: +7 495 9214881
f: +7 495 7253805
sales@intracom-telecom.com

America
3885 Crestwood Parkway
Suite 100, Duluth, GA 30096
USA
t: +1 770 2952500
f: +1 770 2952600
sales@intracom-telecom.com

Middle East & APAC
Building No. 3, Office No. 204
P.O. Box 500517, Dubai
Internet City, Dubai
United Arab Emirates
t: +971 4 3625666
f: +971 4 3904279
sales@intracom-telecom.com

Africa
Unit 18 Mezzanine, Oxford Office Park
3 Bauhinia Street, Highveld Technopark
Centurion, Gauteng
South Africa
t: +27 12 8800260
f: +27 12 8800268
sales@intracom-telecom.com

India
Office No. 808-A, 8th Floor
Welldone Tech Park, Sohna Road
Sector 48, Gurgaon, Haryana
India
t: +91 124 4738500
f: +91 124 4738555
sales@intracom-telecom.com