Enabling Critical Networked IT Applications on the Military Base With Reliable Carrier Ethernet Over Copper and Fiber

Actelis Networks™

Executive Summary

U.S. military bases need a new means of transporting bandwidth. All branches of the armed services are being called upon to implement increasingly sophisticated IT infrastructure and applications, and this requires greater amounts of reliable network bandwidth throughout the installation.

Legacy T1s can no longer scale to meet bandwidth requirements cost effectively. High-speed Ethernet transport is the clear technology of choice for upgrading the network, due to its ability to provide the scalability, not to mention cost effectiveness, interoperability, flexibility and manageability required.

Initiatives driving the need for greater bandwidth on the base include the implementation of high definition surveillance cameras, sophisticated access control, and state of the art VoIP systems. Additional drivers include point of sale (PoS) and centralized monitoring and control of building HVAC[1] systems. Even securing servers, workstations, network appliances, and other devices from cyber threats consumes bandwidth. High-speed LAN connectivity, WiFi, and a variety of sensors are needed all over the base. The bottom line: optimizing operations on base requires the intelligence of networked IT equipment, sensors and devices. That requires having enough reliable, secure, cost effective bandwidth everywhere it is needed.

Military bases have some unique and challenging requirements, which is why the Ethernet solution selected should be designed with those needs in mind. Superior reliability and resilience in high noise environments is an absolute must. The network equipment also has to be able to operate at peak performance under challenging environmental conditions, and provide secure communications.

Bandwidth ranging from 10 to 100s of Mbps is required, and preferably can be provided in cost-optimized increments that fit each specific application's requirement cost-effectively. That bandwidth must be provided to a variety of locations over distances spanning even the largest military installation. The ideal solution could enable powering devices remotely over the network in those cases where no local power is available, offer environmentally hardened options in access devices, and support legacy devices with serial interfaces and T1s in addition to Ethernet.

A gradual and easy migration path toward full consolidation onto Ethernet is invaluable. Easy installation with minimum disruption to base operations is highly desirable, and efficient ongoing network operation and management is an absolute must. Maximum reuse of the copper cable plant is important, as is support for connecting to fiber rings, and the ability to run fiber for new drops. Flexible support for a variety of topologies as well as Ethernet and a variety of serial interfaces is important.

Meeting all those requirements with one solution might seem impossible. But one solution that really does it all not only exists, it is based on a vendor, technologies, and portfolio already deployed and proven around the globe in the networks of the U.S. Army, Navy and Air Force.

Actelis Networks offers the best solution for scaling bandwidth on base with Carrier Ethernet switching access and aggregation over copper as well as fiber. This white paper examines Actelis' technology and portfolio, and describes why Actelis is the answer to meeting the growing bandwidth requirements of networked IT applications.

Changing Network Needs

Military bases of all branches of service are installing increasingly sophisticated IT infrastructure and applications. The purpose of these initiatives is to maximize security, enhance mission-critical communications, and achieve greater efficiency of operations.

Achieving these objectives requires an intelligent, high-speed network that connect an increasing number of devices located all across the base. The installation may have one or more fiber rings connecting the data center and perhaps a few major facilities on campus, but much of the network access connectivity still relies of the copper cable plant. More bandwidth is needed at many locations, both inside buildings and outdoors at selected locations along the perimeter of the base, and within the interior.

The amount of bandwidth and power newer devices consume is rapidly increasing. Take high definition surveillance cameras, for example. Not long ago, streaming video from a standard definition camera consumed only 1 or 2 Mbps of bandwidth. Now, HD cameras stream at 6 Mbps, and 4K UHD and higher resolution requires 13 Mbps or more.

Cameras may also require additional power for heating, remote control, and even to support some in-camera data processing for applications like facial recognition. In addition, these cameras may need to be

located where a local power source is not readily available.

Access control systems are also becoming increasingly sophisticated. While CAC cards may be fine for access to some areas, the use of multi-factor authentication techniques is increasingly used, sometimes even leveraging more data-intensive biometrics.

The ability to capture high resolution images or video at base gates and access control points is increasingly important, and the use of sensors to detect explosives or other hazardous materials is increasingly necessary.

Voice traffic is being consolidated onto Ethernet with military-grade VoIP systems, driving yet more data on the LAN.

Point of sale (PoS) systems must access centralized databases, and require fast network connectivity. Medical imaging files are large, and must often be obtained from or distributed to remote points over the network.

There may be need to share files created in multimedia-intensive applications with defense contractors, other bases, or the Pentagon – and no one working on a high-speed LAN wants

impeded by an access bottleneck when trying to access the Internet.

Effective cyber security requires the ability to remotely perform vulnerability analysis, file integrity checks, traffic monitoring, and configuration management over the network.

Efficient, cost-saving operation of building HVAC systems requires centralized, networked monitoring and control.

The bottom line is that the ability to quickly access systems, data and devices, clearly and reliably communicate, and monitor system and network performance and traffic in real-time is essential. Pushing configurations, centrally processing and archiving data, running analytics, and creating dashboards and reports has become mission critical. Real-time information flow is the lifeblood of efficient operations on the modern military base.

Dealing With The Current Network

Consolidation of applications over Ethernet and RJ-45 interfaces is the goal. But the current network still often relies on T1s, many devices still use serial interfaces, and it is desirable to utilize the installed base of copper cabling.

Having a good migration path can be just as important as finding the best transport solution, and ideally you want both. A network solution that leverages the installed base and enables a gradual migration as well as providing flexible, cost-effective, reliable Ethernet is ideal.

The Actelis Networks Solution

The Actelis portfolio consists of aggregation switches, access switches, repeaters, and network management. Actelis' solution is MEF CE 2.0 certified, and offers the flexibility to manage traffic and QoS, ensuring proper treatment of priority traffic.

A key differentiator of the Actelis solution is its ability to carry bandwidth for up to 60 miles and offer bandwidth in increments up to 100s of Mbps over the copper cable plant. The solution also supports connectivity with fiber rings, and works with drops over fiber to new locations where no legacy cable plant exists. It provides a reliable, scalable and cost-   effective solution

for years to come over copper, the ability to operate in a hybrid copper/fiber network, and the ability to gradually migrate to fiber over time.

The Actelis broadband over copper capabilities rely on G.SHDSL and VDSL2-based "bonded copper" technologies, and is used in systems not only in the military, but also at airports and in many commercial applications where reliability is critical, such as railway and utility networks.

The kind of performance attainable with Actelis over copper surprises many people; the amount of bandwidth the possible with 4 and 8 pairs at a distance of 5 kft is shown in *Figure 2.*

Figure 2: Performance over G.SHDSL and VDSL2 with 4 and 8 pairs

Two and 4-pair solutions offer lesser or greater performance at these distances. Throughput declines with distance, but using repeaters enables extending out to distances of up to 60 miles. A chart showing performance of Actelis G.SHDSL using 8 pairs is shown in *Figure 3.*
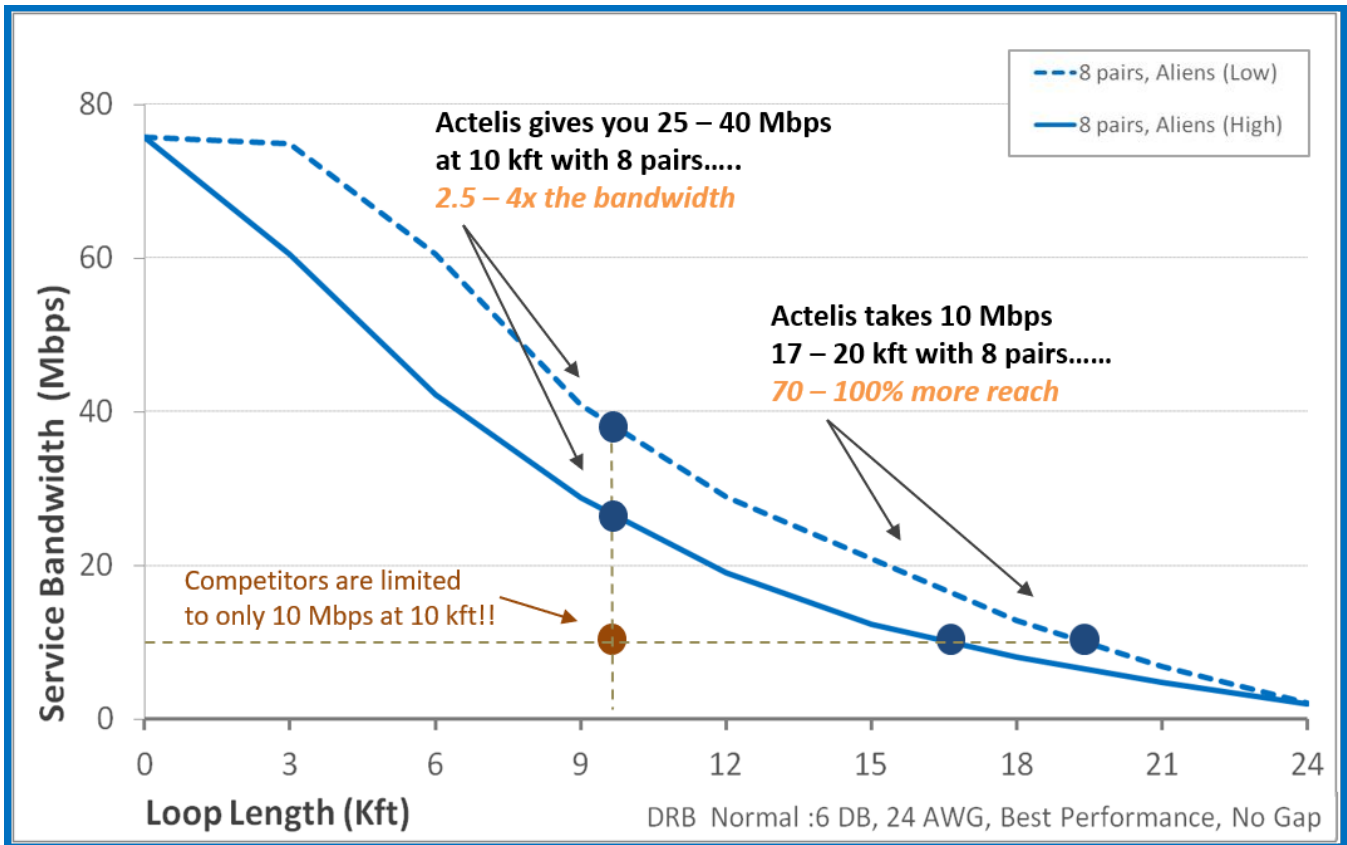
Figure 3: Bandwidth Over Copper Available Using G.SHDSL and VDSL2 Bonding

Note that these distances can be extended much further with repeaters.

Actelis' performance is based on logical "bonding" of multiple copper pairs. With bonding, a high-speed signal is broken into separate, slower streams, each of which are simultaneously transmitted over one of the bonded pairs.

At the far end, the lower-speed signals travelling over each of those pairs is then reassembled into a high-speed stream. Anywhere from 2-16 pairs can be used to provide different amounts of bandwidth over various distances.

The solution is resilient to near-end and far-end crosstalk and EMI, is low in latency and surge protected.

A depiction of the bonding process separating a large bandwidth input into multiple lower speed streams, then reassembling the high-speed stream on the far end, is shown in *Figure 4.*
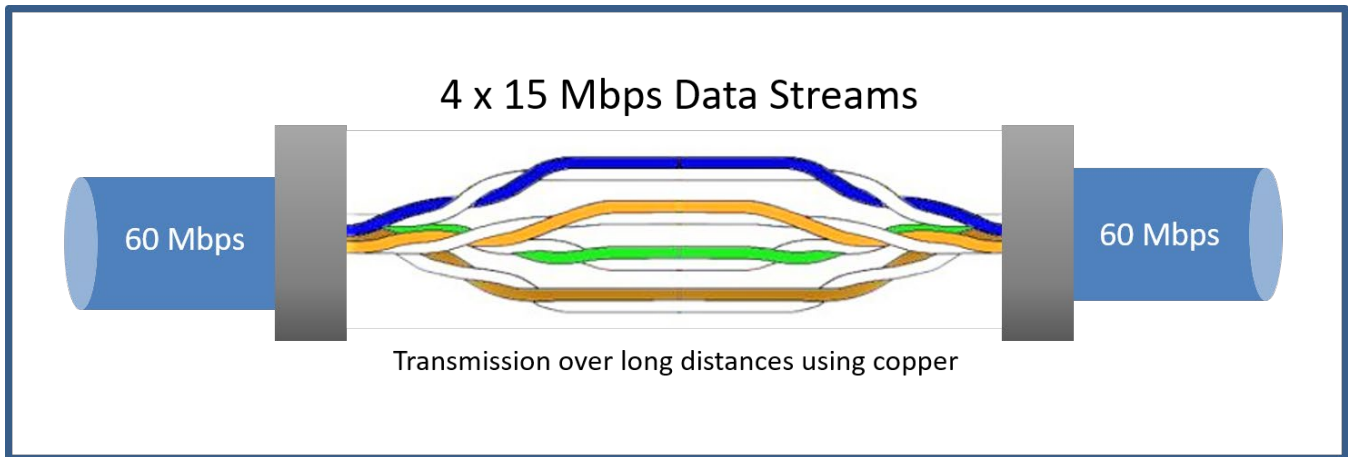
4 x 15 Mbps Data Streams

60 Mbps

60 Mbps

Transmission over long distances using copper

Figure 4: Bonded copper splitting 60 Mbps from a 10/100 connection into four 15 Mbps data streams

In addition to getting high speed performance over copper, the bonding process makes for high security transmission. Since traffic is split across different pairs in a cable and the transmission rate varies on each, identifying which pairs are bonded, and reassembling the proper sequence of data from the individual streams transmitted on each pair would be extremely difficult. Performance of the solution yield over 1 Gbps with fiber; with G.SHDSL and VDSL2 bonded copper, hundreds of Mbps can be supported - as shown in the chart in *Figure 5.*

	G.SHDSL	**VDSL2**
Service Type	**Symmetric** Special profiles can support asymmetric traffic	**Asymmetric** Special profiles can support symmetric traffic
Bonding	**Up to 32 pairs, up to 400 Mbps** Enabling extended reach and higher bandwidth if pair are available	**Up to 8 pairs (today), Up to 750Mbps**
Max Bandwidth per Pair	**Up to 15 Mbps**	**Up to 100 Mbps**
Max Bandwidth per Link	**100+ Mbps with 8 pairs 200+ Mbps with 16 pairs 400+ Mbps with 32 pairs**	**750 Mbps with 8 pairs 300 Mbps with 2 pairs**
Main Targeted Coverage	**Medium to Long Reach**	**Short to Medium Reach**
Reach Extenders	**Repeaters , Up to 9 hops**	**Broadband Amplifiers* , One Hop**

Figure 5: The Bandwidth And Distance Capabilities Over Copper

Technology

Actelis' EFMplus™ suite of technologies and algorithms overcomes EMI, crosstalk, and transients in the network to make this kind of bandwidth over copper possible. Dynamic Spectral Shaping (DSS) applies advanced Power Back-Off (PBO) mechanisms combined with efficient spectrum utilization techniques, significantly reducing the spectral impact of the system while maximizing link performance. Coordinated calibration of modems monitors bit rate and SNR margin for each modem driving a cable pair, and adjusts that to optimize performance of the overall link. As a result, reliable, high performance transmission can be achieved over even old copper cabling that is not of the best quality.

Portfolio

Actelis has a full family of aggregation switches and access switches tailored to different capacity needs.

The Actelis Ethernet Aggregation Switches

Deployed at the data center, equipment room, or cabinet, the Actelis Ethernet Aggregation switching portion of the solution includes cost optimized options: he 256-pair, 4U ML2300, the 64-pair, 2U ML230; 1U, 16-pair ML6916E.

Actelis ML230 and ML2300 Aggregation Switches

The Actelis Ethernet Access Switches
The Actelis access portfolio consists of G.SHDSL and VDSL2-based products, and supports both copper and fiber. MEF CE2.0 certified, these switches offer a full suite of advanced traffic management and QoS features, enabling prioritization and separation of critical traffic.

Actelis also offers a very compact line of environmentally hardened, fanless access switches designed specifically for use in environmentally challenging and space-constrained, confining environments – which offer remote power over Ethernet with PoE+, and can be used to provide up to 60 Mbps of bandwidth and up to 125 W in aggregate to power both the access switch and multiple devices it provides connectivity to over the very same pairs.

Repeaters

Repeaters act as solution extenders, increasing distances for Actelis' high speed broadband solutions up to 60 miles.

Interfaces and connectivity

Actelis provides a very flexible solution supporting options for Ethernet and serial interfaces, terminal server, and media converters to make interconnectivity simple.

Management

Both copper and fiber can be managed on the same platform, giving network operations personnel efficient, synergist control over their access network assets.

Two Examples of The Power of High-Speed Bandwidth over Copper Solutions

I.   Actelis can support both Ethernet switches, other devices, and power over the same copper cable pairs, dropping bandwidth serially at various points along the way, as shown in **Figure 6** below.
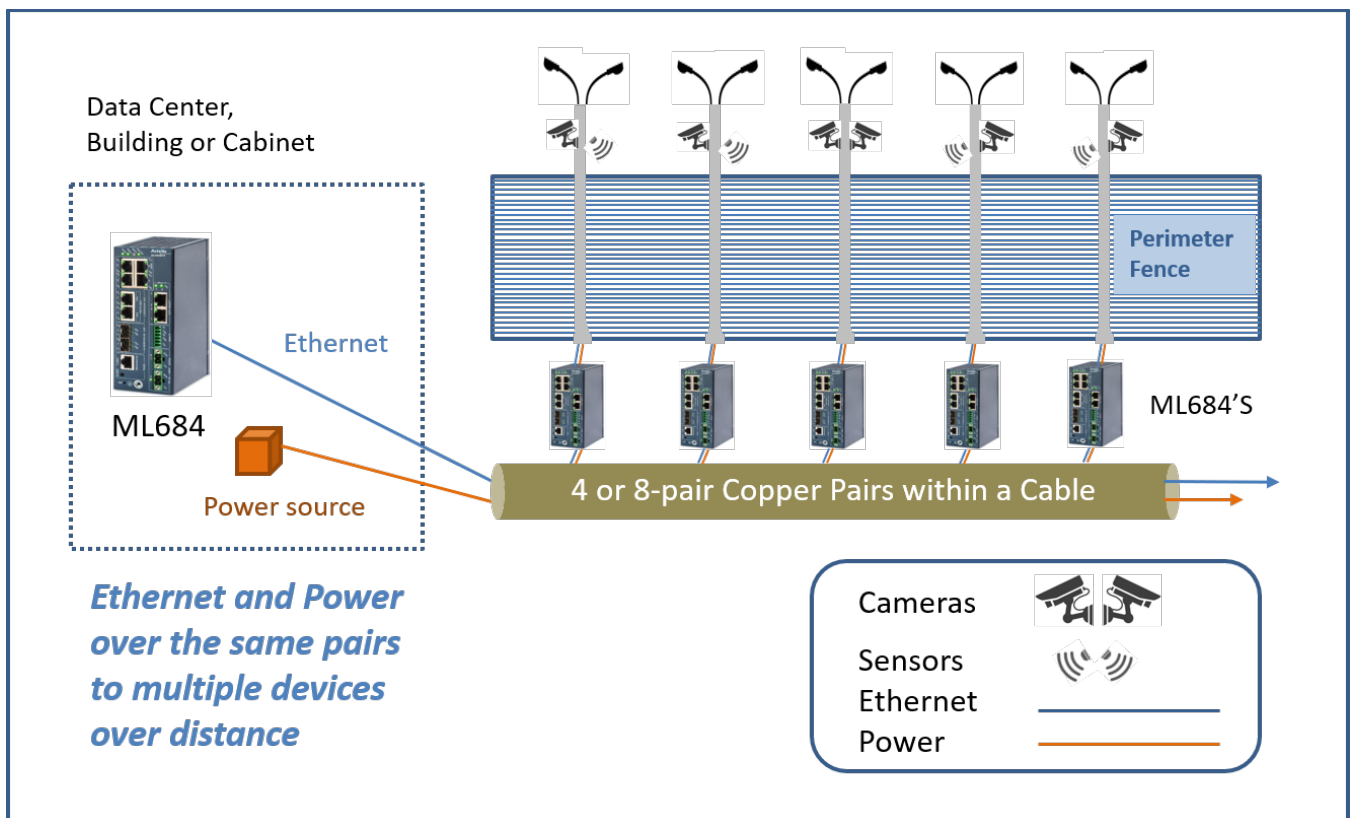

Figure 6: Drop and Continue With Ethernet and Remote Power Over Copper

II.   With only a single 2U ML230, Actelis can provide up to 30 Mbps of bandwidth over only   2 pairs of copper to up to 64 barracks on the base. Plus copper can provide far more bandwidth wherever needed over distances of up to 60 miles as shown in Figue 7.
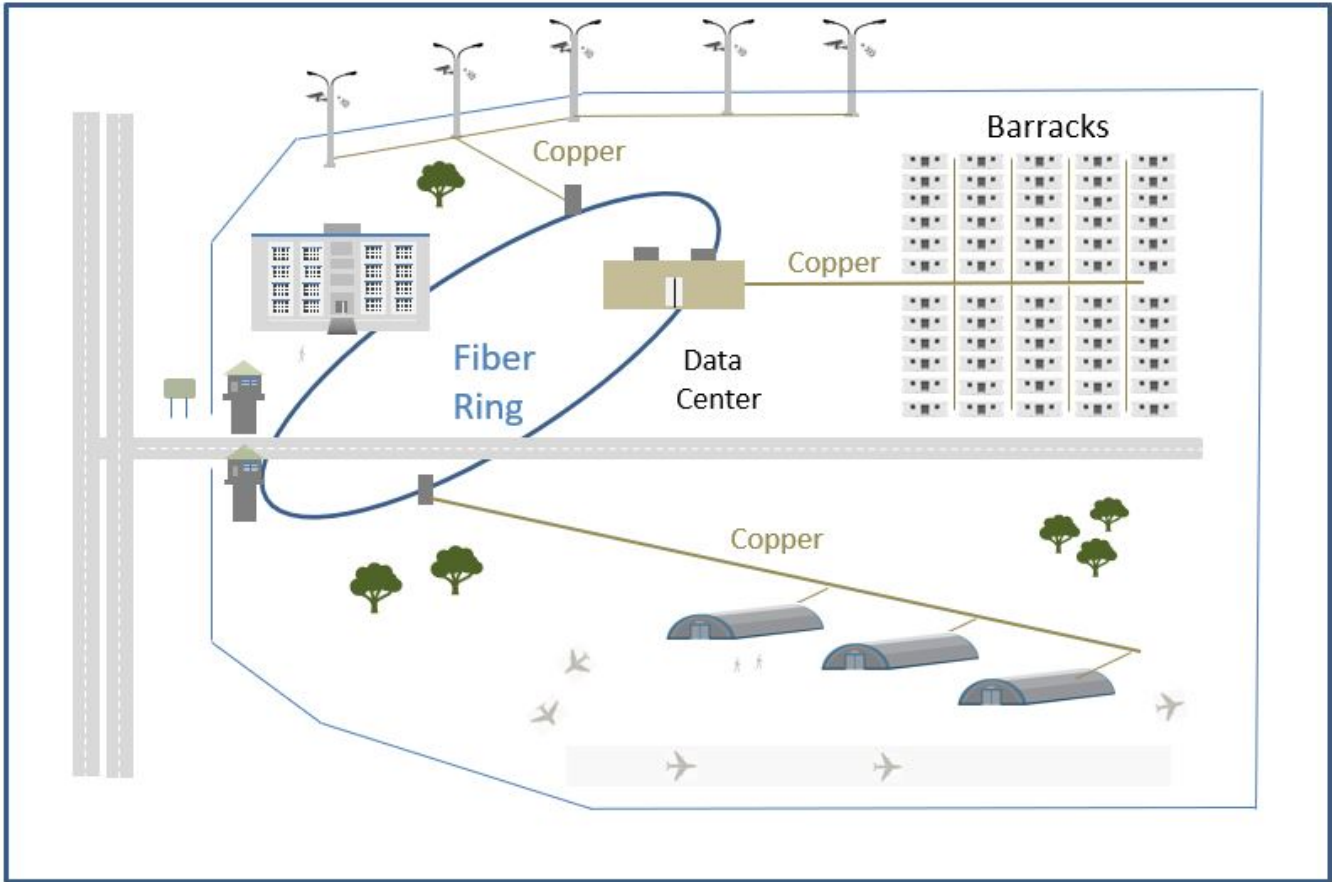

Figure 7: Connectivity over Fiber, Copper, and Hybrid Fiber/Copper on the Military Base

How Actelis Enables Key Initiatives in Networked IT

VoIP	**VoIP** introduces mission critical traffic to the LAN. Having absolute reliability is essential for mission critical VoIP communication – not just in terms of availability, but also in terms of quality and clarity of communication. Low jitter and latency is critical for this application, as is the ability to prioritize this traffic appropriately. Actelis' EFMplus™ technology, advanced traffic management and QoS features make that possible.

Surveillance Cameras	Surveillance cameras are introducing a number of challenges in bandwidth and power. Serving high definition cameras' bandwidth requirements is challenge enough. But getting both that bandwidth and power to remote locations can be extremely expensive and time consuming. Actelis' drop and continue feature enables using the same copper pairs to drop bandwidth to multiple cameras serially along the cable. Its hardened access units not only drop bandwidth to multiple cameras or other devices over the same pairs, but can also provide up to 125 W of aggregate Power over Ethernet. So you can easily power both the Ethernet switch and several other devices subtended off that switch remotely if needed. Actelis not only gives you high bandwidth and power where you need it, but efficient sharing of copper pairs by a number of devices, and the ability to prioritize the traffic streams from those devices.
Access Control systems	Access Control Systems are becoming increasingly sophisticated, and require more bandwidth than they once did. Security is a must. Often used in conjunction with imaging or video systems and sensors, access control must access centralized databases quickly and be highly reliable – and need more data for multi-factor authentication and increasingly complex biometric systems. Actelis provides a cost effective means of getting reliable, secure, low-latency bandwidth out to connect every access control point on the base – leveraging either hard-to-tap fiber or the inherent security over copper introduced by Actelis' copper bonding with EFM*plus*™ technology.
Building HVAC systems	Building HVAC system management is more efficient when done from a central location. Having dedicated, centralized management of these systems ensures stabilization of controls to maintain comfort for personnel and stable operating conditions for computer and network equipment as weather conditions change. It also results in a major cost savings, as settings can be managed and adjusted appropriately based on the utilization patterns for each building throughout the day.

	Actelis provides a number of flexible interface options on its access switches, allowing you to easily consolidate MVAC and a number of other applications that might possibly still have serial interfaces onto an Ethernet LAN.
Backhaul for Wireless	Backhaul for wireless communications is another application where Actelis solves a key problem. Placement of antennas is critical to maximizing coverage and performance. With Actelis, hundreds of Mbps of bandwidth over copper or 1 Gbps over fiber can be supplied to the ideal locations for an antenna or hotspot. Actelis' bonded copper and fiber both can get high-speed bandwidth to the right location securely.
Cyber Security	Cyber Security is reliant on having real-time network bandwidth available all over the base. Monitoring servers, workstations, network appliances and other devices for vulnerabilities, checking the integrity of files, and monitoring traffic flow and data exchange over the network is required.

Why Actelis?

1	Experience earned in military and government Carrier Ethernet applications
2	Proven reliability and resilience
3.	Ability to provide 100s of Mbps of bandwidth over even older, less than ideal copper cabling
4	Lowest cost per Mbps
5	Flexibility to use copper, fiber, or a hybrid of the two
6	MEF CE2.0 rich suite of features enabling traffic management, QoS and prioritization
7	Remote powering of access switches and other devices over copper
8	Support for both bandwidth and power over the very same copper pairs
9	Drop and Continue feature supplies bandwidth to multiple devices using one set of pairs
10	Reach extending up to 60 miles
11	Options in environmentally hardened access units
12	Unified copper and fiber management
13	Highly dense, stackable aggregation solutions with options in protection, redundancy
14	Cost-optimized sizes in aggregation and access switches tailored to your needs
15	Plug 'n play operation
16	High speed copper and fiber supports diverse access media applications
17	Complementary network design tools
18	Extremely reliable equipment with local MTTR

19	Very high resilience to EMI for top performance in noisy locations
20	Inherent security of traffic over bonded copper and fiber

Conclusion

Military bases deploying new systems, devices, and applications require more bandwidth, and need to consolidate as many applications as possible onto reliable, scalable Carrier Ethernet. Bandwidth, distance, environment, and power can all be challenges to overcome in the military base. Actelis Networks has the Ethernet aggregation and access solution purpose built for this kind of environment. Actelis provides 100s of Mbps of bandwidth over copper or fiber, effectively supporting legacy T1s and serial devices while building the right next-gen Ethernet network. Actelis offers the best combination of performance, flexibility, and operational simplicity required to meet current and future needs for bandwidth on the base.

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