

2014 Digital 21 Strategy – Smarter Hong Kong, Smarter Living

Submission by Cambium Networks to

Office of the Government Chief Information Officer

Cambium Networks is delighted to provide its guidance in this submission for the “Smarter Hong Kong, Smarter Living” strategy. The Digital 21 Strategy’s aim is to empower residents with ‘City-wide Wi-Fi for the public and visitors’ and provide ‘broadband and Wi-Fi access for schools to drive e-Learning’. This will be the essential infrastructure in enhancing Hong Kong’s competitiveness and public digital literacy in the digital era.

We all recognise the impact of reliable and meaningful connectivity in empowering everyone in the city with access to the knowledge, tools, and resources held on the internet.

As a leading global provider of wireless broadband solutions that connect the unconnected, Cambium Networks would like to share the insights we have gained from developing our extensive portfolio of reliable, scalable and secure wireless broadband solutions, a decade of experience in helping global businesses, educational institutions and government departments, as well as the rich heritage of Orthogon Systems and Canopy Networks.

I. Challenges

Even though Hong Kong’s internet connection speeds, broadband and mobile penetration rates at 85% and 231% are among the highest in the world, there are people living in areas with limited internet access and unstable network connectivity. Furthermore, e-learning is still not yet fully implemented in all schools, mainly due to the technical barriers limiting the scalability, affordability and flexibility of internet access.

Wi-Fi networks face challenges such as self-interference due to many like devices in close proximity, which affects a devices ability to efficiently deliver a good quality internet connection and inhibits school-wide deployments of wireless devices.

With limited fibre optical network service coverage, residents living in rural villages in Hong Kong like Fanling Wai, Ho Sheung Heung and Kwu Tung etc. have to bear expensive installation costs for broadband services, which presents one of the main barriers to achieving genuine City-wide Wi-Fi coverage.

Besides the Wi-Fi networks, congestion in cellular networks during large-scale events such as the New Year countdown, lunar New Year fair or concerts in Hong Kong Coliseum could also potentially negatively impact Hong Kong’s position as one of Asia’s top tourist destinations.

II. Solutions

In light of the above, we would like to introduce the Point-to-Point (PTP) backhaul and Point-to-Multipoint (PMP) access network wireless broadband technology, as well as the ePMP, which is designed to equalise broadband access across the world, as the suggested solutions to the Digital 21 Strategy in Hong Kong.

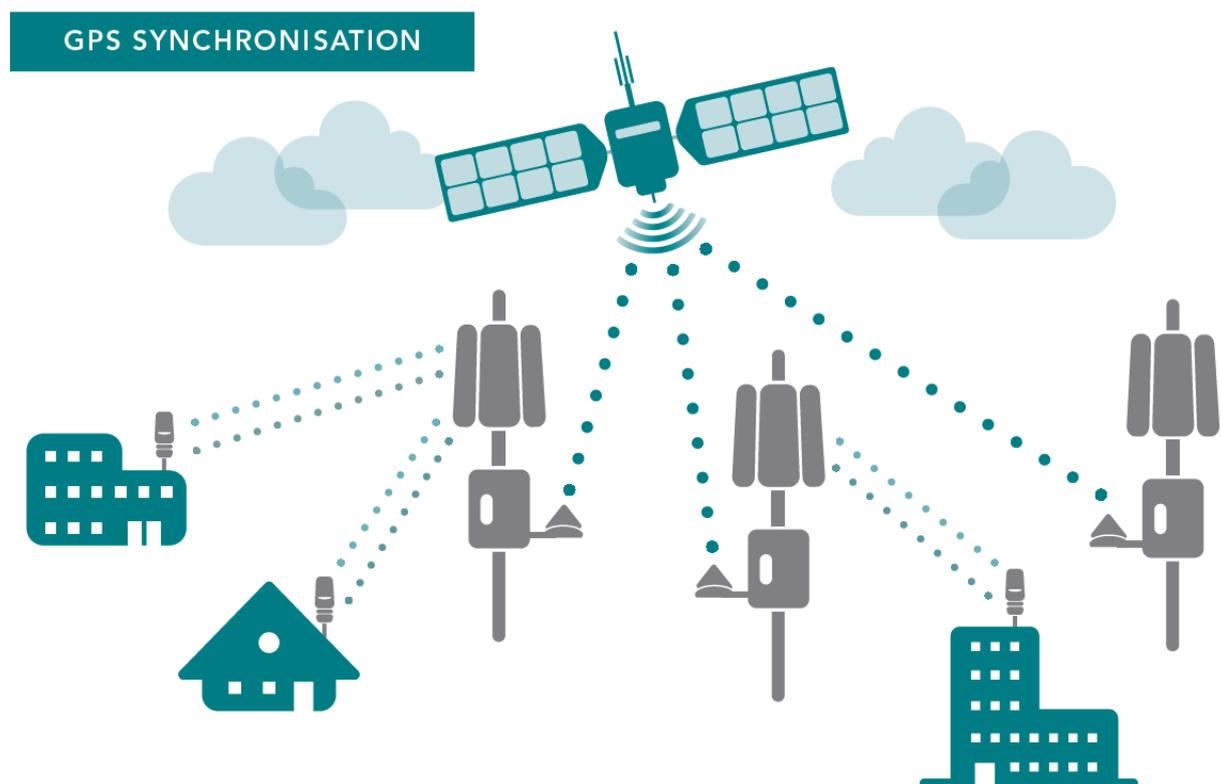
II.I Connected Device for Every Student in Every Classroom

Fixed wireless broadband has emerged as the most cost-effective technology for delivering high-speed internet access to residential and business users. One of the major challenges for wireless network providers is to ensure their equipment’s ability to overcome the effects of interference, and deliver reliable, resilient and secure services. It is a fact that fixed wireless systems, whether operating in licensed or unlicensed frequencies, must cope with interference that can disrupt signals and cause transmission delays. Interference can be mitigated by using a

fixed wireless solution that is designed with synchronised delivering consistently reliable performance and connectivity, enhanced user satisfaction and positive academic and sociological impact.

Cambium Networks solutions reduce interference in many ways, which include the following unique interference-neutralising solutions and typical techniques used in minimising ambient noise.

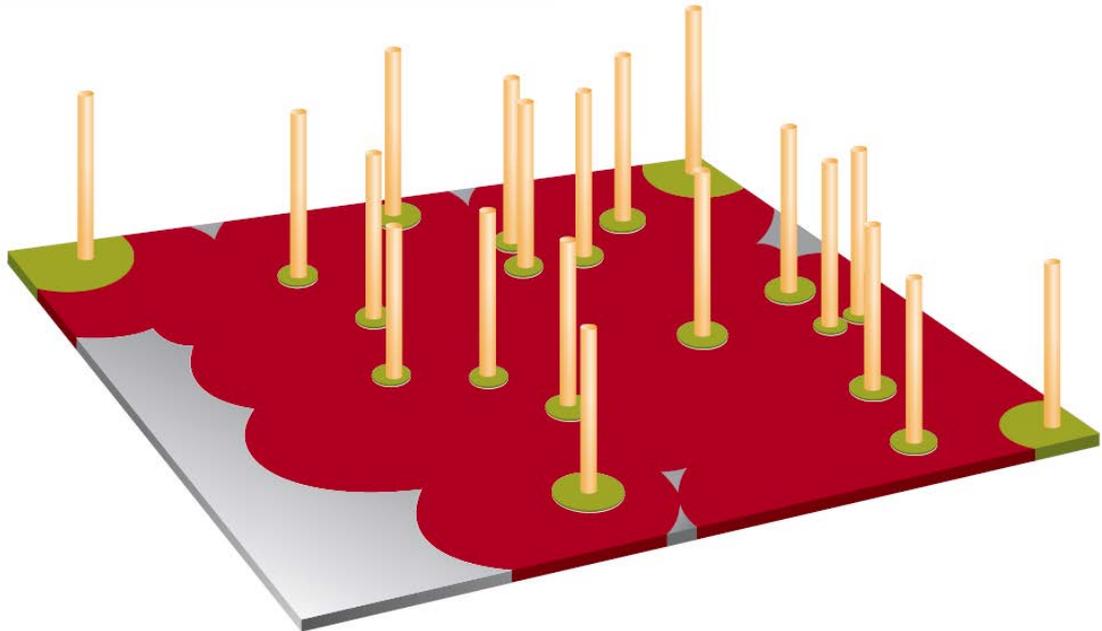
GPS Synchronisation. Cambium leads the wireless industry in its usage of powerful GPS synchronization capabilities in all its PMP networks. This valuable capability dramatically reduces self-interference in both licensed and unlicensed frequency bands. GPS synchronization allows all sites to be set to the exact same clock so network timing is very precise. As shown in the diagram, GPS satellite timing signals reach the GPS receivers in each of the network's access point radios, establishing a common timing reference. This allows all the access point radios in the network — whether hundreds or thousands — to transmit at the same time and alternatively receive as all subscriber modules in the network transmit at the same time in turn. This helps prevent radio signals transmitted by an access point transceiver to interfere with reception of a user signal by another access point transceiver, perhaps the most onerous kind of self-interference in time-division duplex radio networks. With GPS synchronization, service providers can be certain that their networks can scale and grow elegantly to serve increasing numbers of users and applications.



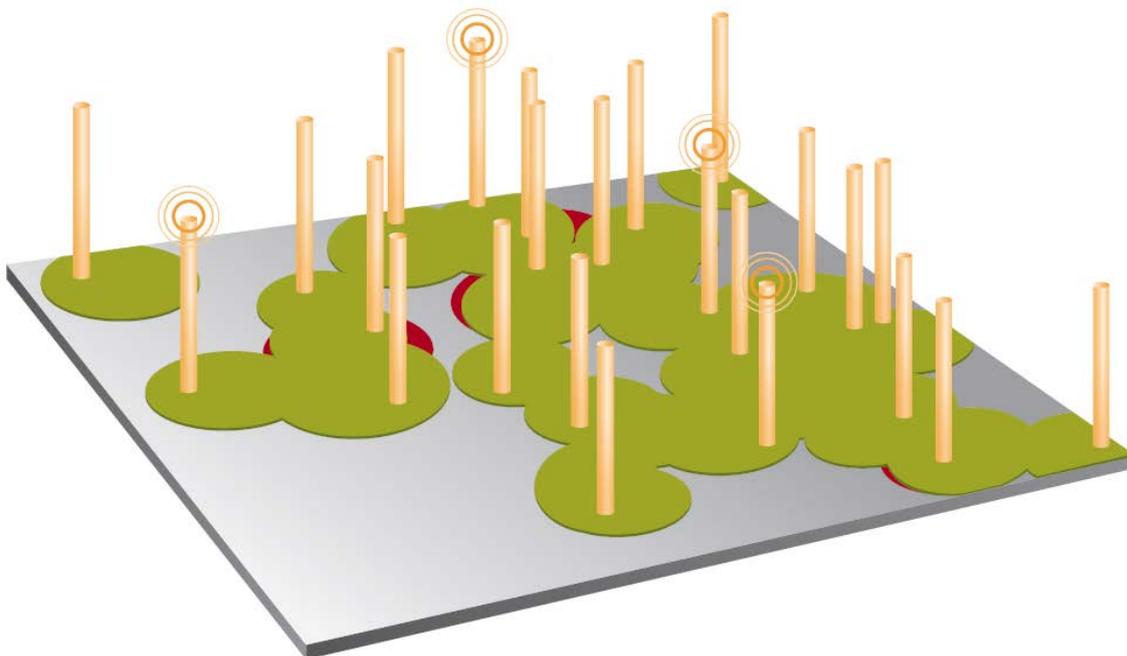
Equipment key:

- Point-to-Multipoint access point cluster & cluster management module
- GPS antenna
- Point-to-Multipoint subscriber module

CARRIER-TO-INTERFERENCE RATIO



Poor coverage in an unsynchronised dense deployment due to high interference



PMP coverage in a synchronised dense deployment – large area of good coverage with little self-interference levels

Directional Antennas. Antennas focus RF transmissions and eliminate susceptibility to signals from outside of the transmission area. Cambium PMP products use directional antennas to focus and narrow the signal beamwidths to make them more efficient, strengthening the main signal while minimising side and rear signal leakage and reducing interference to other transmissions. This reduces the noise floor from unwanted transmissions including emissions from other devices and networks in the spectrum.

Cambium Air Interface Protocol. For the most effective interference mitigation, it is crucial to have a network designed to prevent or reduce unwanted signals. This begins with the design approach taken in the Media Access Control (MAC) layer. Unlike many other systems, Cambium designs its MAC frame to carry radio data packets (RDP) of a relatively small size. If and when interference corrupts reception of an RDP, the small size means that retransmission of RDPs is kept to a minimum, assuring a negligible impact on overall network throughput. Cambium's PMP equipment also incorporates centralized request-grant transmission control that reduces demand contention and allows subscriber modules to transmit data only when permitted by the access point, reducing data packet corruption and retransmission and maximizing throughput.

Noise Filters. Cambium PMP networks also provide leading edge noise filters that help reduce the effects of interference from signals in the neighbouring frequencies, thus improving reliability of communications.

Carrier-To-Interference Ratio (C/I) Ratio. The C/I ratio measures signal strength versus interference strength. The lower the C/I ratio, the more difficult it is to distinguish the desired incoming signals from the interference. Cambium PMP networks are known for their exceptional ability to decode incoming signals and maximize performance in low C/I environments. Because of their unique design, Cambium radios need a minimum amount of signal above the interfering signal to operate successfully, as shown in the diagram. The result is, in many situations, Cambium radios will work where other radios cannot.

Endorsements to the Cambium Networks' PMP Solution

"We use the Cambium PMP solution because we've found it to be the most resilient connection in our type of urban business environment. The solution keeps the signal strength high, even with rain and interference, providing C/I ratios that allow us to deliver 100% throughput." Shane Hampton, Vice President of Market Development at Business Only Broadband, the largest fixed wireless broadband provider in Chicagoland, with additional presence in the Milwaukee and New York City metropolitan areas, said.

"We found that the carrier-to-interference ratio on the Cambium system is so small that the system can operate with substantial interference and still maintain higher-quality of service than alternative equipment. Even in congested bands, the Cambium equipment gives us great penetration in the high foliage areas and mitigates interference amazingly well." Mark Novey, Director of Information Technology of Telpage, a privately owned and managed, Mid Atlantic based mass communications company, said.

Case Study

With more than 800 languages officially recognised among its seven million people, Papua New Guinea has some of the most difficult geographical and challenging weather conditions anywhere on earth. Approximately 80% of its population live in remote villages with no road access.

The challenge for Digicel Business, Cambium Networks' partner, was to connect the country's Department of Education's head office with its regional offices, serving over 10,000 schools across the country in some of the remotest locations. With no internet access, the administrators and teachers at the regional offices had no modern systems or applications, meaning they were unable to perform simple transactions and tasks, such as payroll.

The solution was Digicel Business' Private Branch Networks VPN service, a unique service that has been tailored to provide secure VPN (virtual private network) connectivity for branch offices and low latency resulting in fast response. Playing a key role was Cambium's PMP430, a fixed wireless broadband solution that operates in the 5.4 GHz and 5.8 GHz frequency bands, and extends high-speed connectivity to un-served and hard-to-reach locations and customers at low investment costs. Equipped with OFDM technology, the PMP430 delivers outstanding

throughput, long range, line of sight (LOS) and near-line of sight (nLOS) performance for reliable and secure data, voice and video connectivity.

With the effective combination of Cambium's Point to Multipoint PMP430, and Digicel's countrywide coverage, implementation has been ongoing since March 2012, enriching the learning experience for students and teachers. Consistent and reliable connectivity has been achieved for the first time, allowing all staff to have unprecedented access to vital tools and services.

"Bringing together the Cambium PMP430 with our own virtual private network service allowed us to provide connectivity to thousands of schools through the Department of Education offices across Papua New Guinea. Connecting the department's offices across the country provides a critical line of communication, enriching the learning opportunities for students," Gary Seddon, CEO of Digicel Business, a leading global communications provider with operations in 31 markets in the Caribbean, Central America and Asia Pacific, said.

II.II Affordable Wireless Broadband Access in Rural Villages

The expansion of fibre optical network in rural villages would require approval procedures from a range of involved parties, such as the highways department, district rural committees, environmental groups and village residents. Such influences can prove costly and delay the progress of deployments.

With the ePMP wireless broadband solution at an affordable cost, local wireless broadband service providers can provide reliable, high-quality broadband connectivity that can be rapidly deployed and expanded without digging up the road. The new ePMP solution provides stable coverage across large service areas and complements existing infrastructures.

Cambium's radios support an impressive 200+ Mbps throughput to deliver bandwidth-intensive services such as VoIP (Voice over IP), video and data to end users across multiple vertical markets. The ePMP is optimized for outdoor applications, offering connectivity up to 21 kilometers per access point with one efficiently PTP and PMP integrated radio.

Using the 5 GHz frequency spectrum, the new ePMP architecture covers major unlicensed global bands and is the most effective connectivity solution for the under-connected and unconnected around the world. The key features and target segments of the new ePMP solution include:

- GPS Synchronization for seamless scalability and minimal interference.
- Quality of Service (QoS) ensures superior consistency and integrity for VoIP (Voice over IP), video and data services.
- Reliability is provided by quality components that have been rigorously field tested to minimize service requirement and maximize performance.

Wireless Service Providers (WISPs)

- **Rural and Municipal Connectivity** – Rapidly expand customer base and service offerings by reaching new business and residential subscribers in distant and high-density areas. Increase revenue by offering high-throughput low-latency services including VoIP (Voice over IP), video and data.
- **Remote Office Connectivity** – Efficiently deploy reliable wireless connectivity to remote offices in hard-to-reach areas, increasing presence, market share and revenue.
- **Primary or Redundant Connectivity** – Provide primary wireless connectivity to networks of any size located in remote locations. Expand capabilities and ensure stability by providing secondary wireless links in case of primary wire line failures.

Other than providing affordable wireless broadband connectivity to residents in local villages, the ePMP solution also brings opportunities to traditional businesses in rural areas such as soy sauce plants, organic vegetable farms and village cuisine restaurants etc. to transform their operations with innovative technologies.

Enterprises

- **Video Surveillance** – Monitor large, dense work locations, remote unmanned sites, isolated regions prone to environmental disaster and areas of suspected criminal activity.
- **Device/Site Monitoring** – Increase effectiveness of Industrial Control Systems (ICS) by monitoring and evaluating the entire physical infrastructure, across multiple sites and long distances.
- **LAN Extension** – Build a wireless infrastructure to connect indoor wireless local area networks (WLANs), creating a complete wireless IP network for private, and campus-style connectivity.
- **Leased Line Replacement** – Rapidly establish secure links from building to building or to remote branch offices at a fraction of the cost of telecom leased lines or deployment of wire line broadband systems.

Case Study – Seattle’s Chinatown is safe and secure using the new ePMP

Situation

The busy Chinatown International District is the centre of Seattle’s Asian American community. This is where Asian Americans live and work together. It is collectively called a BIA (Business Improvement Area), providing a mechanism for businesses and property owners to obtain improvements for their district. Maintaining a flourishing business environment and fostering social relationships is vitally important for the development of this international neighbourhood. The existing wireless mesh surveillance system connected ten cameras over a six square block area to maintain safety. This system was inefficient, unreliable and difficult to support. Cascade Networks decided to find a better solution that would be easier to maintain and expand going forward and better serve this booming multicultural community.

Solution

Cascade Networks, which has successfully provided wireless business and residential services in the state of Washington for many years, selected the ePMP solution from Cambium Networks. This solution was a better fit for their needs because it delivered resiliency and configuration flexibility. It helped to preserve public safety and provide conditions for further business expansion. The new architecture was deployed within several hours and all radios were configured for an integrated PMP-PTP solution.

Results/Customer Benefits

The ePMP solution from Cambium Networks established a reliable and cost-effective video surveillance service in the busy Chinatown International District. The first installation was so successful, flexible and easy to maintain that Cascade Networks decided to roll-out similar systems across other districts. This included businesses and university complexes in the area. Finally, the community got the reassurance it needed about safety and the ability to look forward towards new levels of economic growth.

The most beneficial ePMP features used in the deployments are:

- Downlink/Uplink Ratio Adjustment Capability helps to regulate downlink/ uplink traffic based on video surveillance services that require greater uplink resources.
- TDD (Time Division Duplexing) Cycle synchronized by GPS enables frequency reuse and scalability for APs (Access Points) on a tower. In a four sector deployment only two frequencies are required.
- Graphical Web-based Management User Interface provides comprehensive fault, configuration, performance and security management functions. It is powerful, intuitive and offers a comprehensive feature set.

- Low 5-10 W power consumption minimizes the hardware configuration changes needed to operate and power the new equipment.
- Flexible power options with Cat 5e cable allow to the system to operate on a 12 VDC power supply that was already installed in the exiting radio locations.

Endorsement to Cambium Networks' ePMP solution

“The success of the Chinatown International District, one of Seattle’s key business improvement areas, hinges on the ability of its business owners to work together in creating a safe, flourishing commercial environment in this emerging neighbourhood. The existing mesh networking architecture that had been supporting their video surveillance was unreliable so we quickly made an effective equipment change,” said Brian Magnuson, President of Cascade Networks. “We found exactly what we needed with ePMP. Its reliability for high-quality video surveillance is outstanding, enabling us to offer the District peace of mind.”

II.III Always Connected with Mobile Devices

Recently, Facebook launched the internet.org initiative that supports internet connectivity being a human right. A smartphone – i.e. a device with 3G/4G LTE connectivity – is fast becoming a necessity to most of the Hong Kong people.

As of 1st quarter of 2013, the smartphone penetration rate of Hong Kong is 63%, which is among the highest in the world. Congestion in cellular networks during a large-scale event, causing service delay or even disconnection is disappointing to local citizens and visitors from other countries.

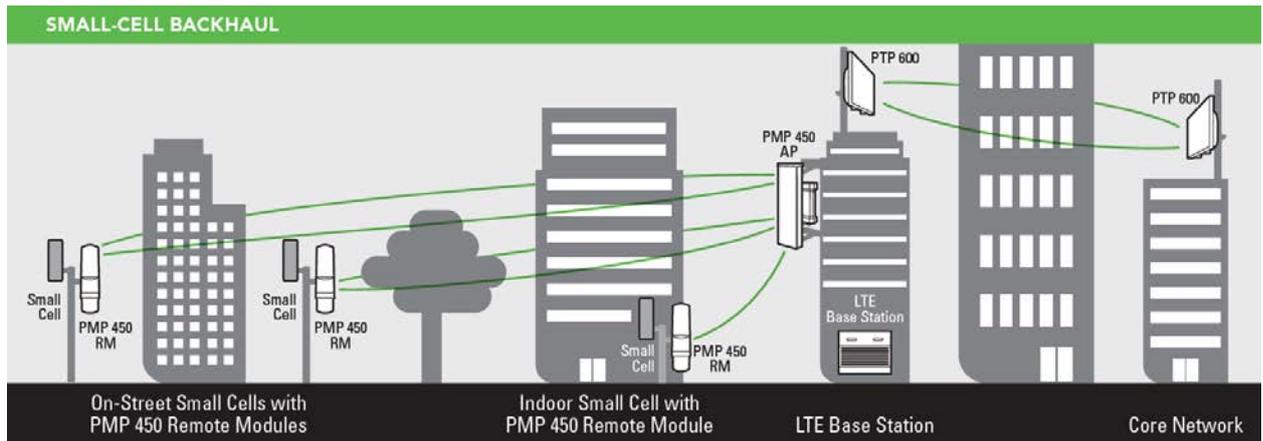
Carriers are aggressively employing small cells to increase capacity in urban areas and provide coverage where gaps currently exist. Wireless technology provides the ability to rapidly deploy reliable small-cell backhaul solutions that can connect where fibre and copper are not available, where fibre may be cost prohibitive (as may occur when spanning long distances), or where time-to-deploy is excessive.

Formerly part of Motorola Solutions, Cambium Networks' Fixed Wireless Broadband solutions deliver reliable, high-performance connectivity in some of the most challenging environments on Earth. We help service providers design the right backhaul solution for multi-technology, small-cell network such as UMTS, HSPA, and LTE.

Cambium Networks' backhaul solutions provide carrier-grade reliability in even the harshest environments. Our wireless Point-to-Point solutions are deployed for LTE backhaul, Wi-Fi Offload, and Mobile Backhaul. OFDM technology and Dynamic Spectrum Optimization enable connectivity in Non-Line-of-Sight applications.

Many large service providers have benefited from our NLOS and interference problem-solving technology, including: AT&T, Bell Mobility, BTiNet, China Mobile, Clearwire, Sprint, Telus, and Verizon etc.

With the high-capacity, scalability and durability, the small cell backhaul supported by the future proof Cambium PTP and PMP wireless backhaul solutions offer high-capacity, flexibility, scalability and reliability that is ready for large-scales events in Hong Kong.



Yours faithfully,
Roy Wittert, Vice President of Sales in Asia Pacific