Report on the Field Test of 80 GHz Digital Fixed Link

Purpose

To evaluate the possible usage of the E-band at 71-76 GHz / 81-86 GHz ("80 GHz") for digital fixed links in Hong Kong. The Force obtained temporary frequency assignment from the Office of the Communications Authority ("OFCA") to conduct the field test. The test setup intended to study the reliability and feasibility of using 80 GHz fixed link in urban areas. The field test was conducted during the period between October 2014 and January 2015.

Field Trial Setup

2. The field trial setup two 80 GHz fixed links using equipment from two different manufacturers. One of the fixed links established between two government buildings at Wan Chai and Central ("First Link"). The distance of the First Link was approximate 1.57 kilometers. Whereas, another fixed link enabled transmission between two government buildings at Central and Sheung Wan ("Second Link"). The distance of the Second Link was approximate 0.68 kilometers. The technical characteristics of these two fixed links has been set out in Annex 1.

Methodology and Findings

First Link –1.57 kilometers line-of-sight

3. Two laptop computers installed *Iperf* software and connected to both nodes of microwave equipment. Both laptop computers generated data stream of 500Mbps in every 10 minutes to both uplink and downlink to emulate the data transmission over the established link. The calculated capacity of this 80 GHz fixed link under 250MHz channel spacing and 16QAM modulation is around 526 Mbps.

4. During the field test period (from 26 October 2014 to 14 January 2015), the link performed reliably and stably but there was one link down incident recorded on 7 November 2014. Apart from that incident, the link was stable, reliable with the Received Signal Level ("RSL") of both nodes kept at a steady

level at around –46dBm under normal weather condition in the test period. However, the link was down for 202 seconds in a recorded 15 minutes interval at 16:00 to 16:15 on 7 November 2014. The rainfall in the period from 16:00 to 17:00 was 5-10mm with reference to the record by the Hong Kong Observatory ("HKO"). The link is significantly affected by rain attenuation even under light to medium rain in which the RSL was dropped to –83dBm at the moment.

Second Link –0.68 kilometers line-of-sight

6. A laptop computer was used to connect to one node of microwave equipment. The transmission and reception data of both nodes of microwave equipment could be retrieved from the web browser of laptop computer. In addition, a network tester was connected to both nodes of microwave equipment and conducted RFC 2544 sweep test from 100Mbps to 1Gbps. The difference in test setup between the First and Second Link was owing to the availability of testing equipment.

7. During the field trial period (from 22 November 2014 to 14 January 2015), the link was operating reliably and stably without down time. The RSL on both nodes was steady, approximately –29dBm under normal weather condition in the test period. The link was not apparently affected by rainy weather under this transmission distance. On 12 January and 13 January 2015, the recorded rainfall by HKO was 5mm at 23:15 and 4mm at 10:45, and the RSL was –37.5dBm and –38.5dBm respectively. Although the link was still available without down time, the RSL dropped approximately 8dB showing that the link was very sensitive to rain attenuation.

8. RFC 2544 sweep test was also conducted in this link. The tester sent continuous data stream from 100Mbps to 1Gbps from one node to another node. With the Second Link configured at QPSK modulation and using 250MHz channel spacing, the calculated capacity is 499Mbps. The link was stable and no frame loss under or equal to 400Mbps. However, frame loss was found when the data stream was increased over 400Mbps. The link data rate is expandable if the microwave equipment is configured the channel spacing from 250MHz to 500MHz.

9. The test results and experiences shown that 80 GHz band is feasible for fixed link application in Hong Kong under normal rainfall weather condition

and a short transmission distance, say few hundred meters. In order to maintain higher availability in high rainfall weather condition, higher fade margin or using bigger antenna to compensate the link budget loss from high rainfall is required to consider during detailed design. However, due to no higher rainfall condition during the field trial period, the performance of the links under such weather condition was not tested.

Conclusions

10. Based on the trial results and experience in 80GHz configurations, some observations are summarized as follows:

    (i) The 80 GHz band is feasible for fixed link application in Hong Kong and it is preferable to be used for short-range fixed link application. However, more fade margin or lower modulation rate could offset rainfall attenuation.

    (ii) It provides high capacity tunnel for data transmission such as applying to high definition video transmission and short-range backhaul for next generation radio system.

    (iii) It allows users to quickly and flexibly setting up the link, and easy to do alignment. Therefore, it can be used for handling ad hoc and temporary user requests.

    (iv) It can be applied to non mission-critical applications in future.

Annex 1

Technical Characteristics of the 80 GHz Fixed link (First Link)

Frequency Band	71-76GHz / 81-86 GHz
Duplex Mode	FDD
Channel Space	250MHz
Operating Frequency	73.25 GHz and 83.25 GHz
Modulation Scheme	16QAM
Transmit Power	11 dBm
Receiver sensitivity	-69 dBm
Antenna Polarization	Vertical
Antenna Size	0.3m diameter
Antenna Gain	43.8dBi
Power Supply	POE (Power over Ethernet)

Technical Characteristics of the 80 GHz Fixed link (Second Link)

Frequency Band	71-76GHz / 81-86 GHz
Duplex Mode	FDD
Channel Space	250MHz
Operating Frequency	74.25 GHz and 84.25 GHz
Modulation Scheme	QPSK
Transmit Power	11 dBm
Receiver sensitivity	-59 dBm
Antenna Polarization	Vertical
Antenna Size	0.3m diameter
Antenna Gain	44.2dBi at 78.5GHz
Power Supply	POE (Power over Ethernet)