Breakthrough in high-speed optical communication

高速光通訊上的重大突破

Researchers at PolyU's Photonics Research Centre have cleverly combined optics, statistics and signal processing technology to achieve an increase in the speed of optical communication network by 40 times, i.e. 4 trillion bits per second.

理大光電子研究中心的研究人員結合光學、統計學與訊號處理技術，將光通訊網絡速度提升四十倍，達到每秒4000億個數字單位。

Jointly undertaken by Ir Prof. Alexander Wai, Vice President (Research Development), Prof. Lu Chao of the Department of Electronic and Information Engineering, Prof. Tam Hwa-yaw and Dr Alan Lau Pak-tao, Chair Professor and Assistant Professor of the Department of Electrical Engineering respectively, this research has resulted in the fastest optical transmission systems with significant cost effectiveness.

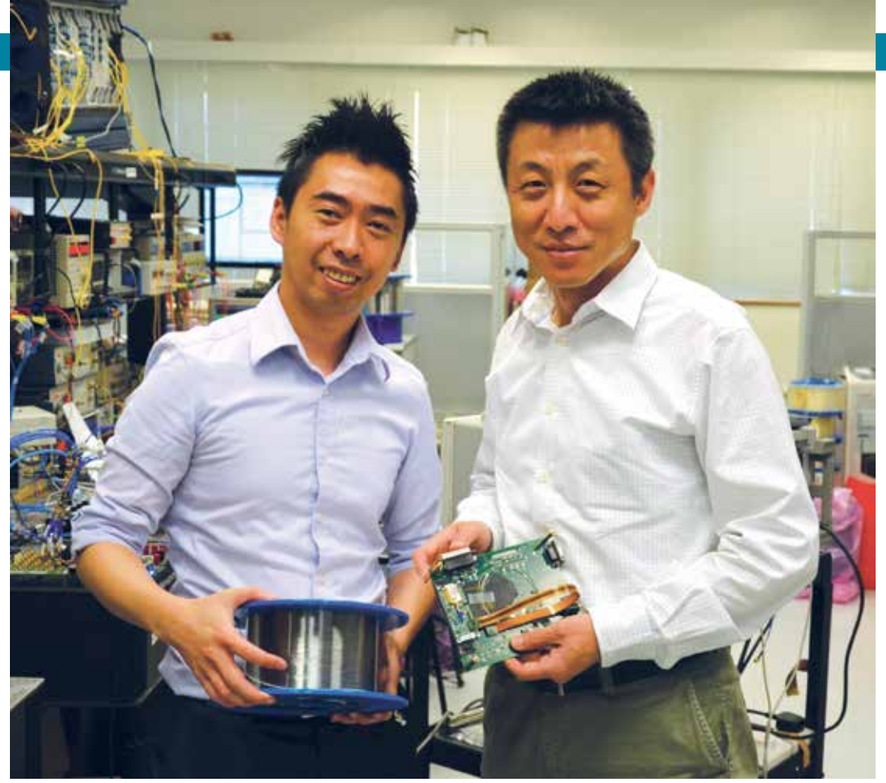
"With this breakthrough, one can download over 177-hours-worth of YouTube video in a second," Prof. Wai said.

The speed of optical communications largely depends on distortions in the information signals generated from their interactions with silicon dioxide molecules that make up optical fibre. However, the higher the speed of information transmission, the more likely the signal will be distorted. When the distortion is large enough, detection errors occur at the receiving end. If the information cannot be correctly transmitted, the whole communication system becomes useless.

Currently, the most commonly deployed optical communication systems operate at 10Gb/s, i.e. 10 billion binary digits (bits) per second. However, the researchers found that distortions in the light signals generated from silicon dioxide molecules inside an optical fibre are not completely random and have certain statistical characteristics. They thus proposed the use of "coherent detection", whereby the optical signal is first converted into an electrical signal to preserve the data being transmitted.

In the past five years, Huawei Technologies Co. Ltd., a leading global information and communications technology solution provider, has provided funding and equipment to facilitate developing and filing patents for this leading-edge technology. The research findings have been published in top international journals such as *Optics Express, Photonics Technology Letters, Journal of Lightwave Technology and Journal of Selected Topics in Quantum Electronics*.

PolyU also attracted partnerships and funding support from other telecom giants. In September 2011, the University worked with NEC Laboratories America in the research and manufacturing of a new type of fibre, few-mode fibre, which supports a triple increase in transmission speed. This achievement has broken another world record. Currently, PolyU is having research collaboration with Corning Incorporated, a leading manufacturer of optical fibres and glass materials.



Prof. Lu Chao (right) and Dr Alan Lau
呂超教授(右)及劉伯濤博士

該研究項目由副校長(科研發展)衛炳江教授、工程師、電子及資訊工程學系呂超教授、電機工程學系講座教授譚華耀教授及助理教授劉伯濤博士負責。他們所研發出的技術，成功打破了全球最快光通訊系統的紀錄，而又符合成本效益。

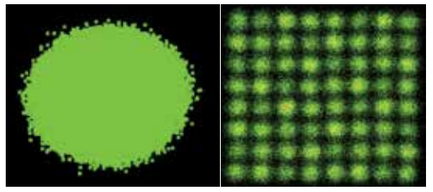
衛教授表示：「採用這突破性高速光通訊技術後，每秒可下載超過177小時的YouTube短片。」

光通訊的速度取決於光纖粒子對光訊號有多大的干擾，越高速的訊號越容易受到干擾，令接收端無法準確接收訊號，因此速度再快也變得沒甚意義。由於光纖裏的二氧化硅粒子會與經過它們的光訊號產生光電磁作用，令光訊號受干擾而無法回復原狀，從而影響了傳送速度。

目前，普遍的光通訊系統速度為10Gb/s－即每秒100億個數字單位。然而，研究人員從實驗中發現，二氧化硅粒子對光訊號的干擾並不是完全隨機，在統計學的角度來看，是有跡可尋的，這樣便能找到相應的電訊號處理技術去還原訊號。因此，他們建議用相干接收(coherent detection)的技術，在接收端先把光訊號轉變為電訊號，然後用相對成熟的電訊號處理技術，補償訊號在光纖裏受到的干擾。

過去五年，全球領先的訊息與通訊解決方案供應商華為技術有限公司投入了設備與資金，與理大共同研發這嶄新技術和申請專利。該研究的結果已在《Optics Express》、《Photonics Technology Letters》、《Journal of Lightwave Technology》及《Journal of Selected Topics in Quantum Electronics》等國際權威學術雜誌中發表。

此外，理大亦與其他世界電信巨頭合作及獲得撥款資助研究項目。二零一一年九月，大學夥拍美國NEC實驗室有限公司研發和製造一種名為少模光纖的新型光纖，其傳輸容量比普通光纖高出三倍，並刷新了世界紀錄。目前，理大正與全球領先的光纖和玻璃材料製造商康寧公司進行科研合作。



By combining knowledge on optics and statistics to form appropriate signal processing algorithms, one can convert a highly distorted signal (left) to a clean and undistorted one (right). This enables higher speed and longer distance fibre-optic transmission.
結合光學和統計學知識，可研發適用於光纖通訊的訊號處理演算法，將嚴重畸變的訊號(左)恢復成規則的、無畸變的訊號(右)，實現高速長距離光纖通訊。