# New architecture delivers super-broadband wired, wireless service simultaneously

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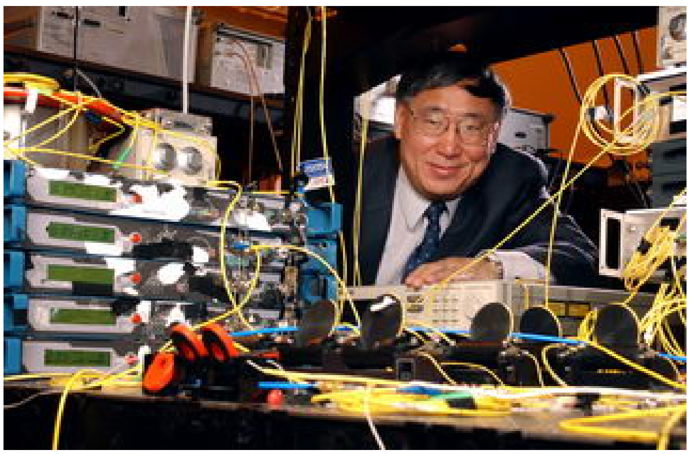

Research Gee-Kung Chang poses with telecommunications equipment used to demonstrate a hybrid wired-wireless network.

Telecommunications researchers have demonstrated a novel communications network design that would provide both ultra-high-speed wireless and wired access services from the same signals carried on a single optical fiber.

The new hybrid system could allow dual wired/wireless transmission of the same content such as high-definition television, data and voice up to 100 times faster than current networks. The new architecture would reduce the cost of providing dramatically improved service to conference centers, airports, hotels, shopping malls – and ultimately to homes and small offices.

"The same services would be provided to customers who would either plug into the wired connection in the wall or access the same information through a wireless system," explained Gee-Kung Chang, a professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. "In an airport, for instance, a traveler could watch a movie, talk to a friend and work interactively through a wireless system or by plugging into the wall."

Chang described the network architecture and experimental demonstrations of it March 10th at the OFC/NFOEC optical conference in Anaheim, Calif. Chang, who holds the Byers Endowed Chair in Optical Networks at Georgia Tech, is also a Georgia Research Alliance Eminent Scholar and a researcher at Georgia Tech Broadband Institute in the Georgia Centers for Advanced Telecommunications Technology (GCATT).

Today, telecommunications providers generally supply services that are either all-wireless, through cellular telephones or similar devices, or all-wired – through DSL, cable or optical access network. As wireless providers seek to provide new bandwidth-intensive services such as video, music and high-speed Internet access, however, the bandwidth needs of wired and wireless services are converging.

The optical-wireless access network envisioned by Chang and his colleagues would connect to existing optical fiber networks that already serve much of the nation. But before entering a building, signals on the optical fiber would be optically up-converted in the central office from their normal infrared wavelengths to the millimeter-wave spectrum. Using a technique developed at Georgia Tech, wireless and baseband signals carried by multiple wavelengths would be converted onto the millimeter-wave carrier simultaneously.

The conversion would be done using one of several all-optical techniques such as external modulator, four-wave mixing (FWM) or cross-phase modulation (XPM) that would not require costly high-frequency electronic devices. The resulting signal would be split into two components and carried by passive optical network (PON) infrastructure installed throughout a building.

One component of the signal would be detected by high-speed receivers built into the ceilings of rooms, then amplified for short-range wireless transmission at frequencies of 40 to 60 gigahertz. The other signal component – carrying identical information – would be accessed through standard wall outlet throughout the building using a low-cost receiver and optical filter.

Either way, users could receive signals at data rates of up to 2.5 gigabits per second, significantly faster than service provided by most Wi-Fi or WiMax systems used at Internet hot-spots and other service areas.

Upstream – from the user back into the network – the system would only need to provide less capacity – likely less than one gigabit per second per user.

Because the capacity of optical fiber is so high, this optical-wireless network could use wavelength division multiplexing (WDM) to carry as many as 32 different channels, each providing 2.5 gigabit-per-second service. That would allow users within buildings to subscribe to services from many different providers, each with their own content.

"You could have one network shared by many providers because bandwidth is not a limitation once you combine the advantages of optical and wireless access systems," Chang noted. "If you look into the future, the broadest bandwidth possible would come through combining and integrating optical and wireless services in a single network."

In his laboratory, Chang and colleagues Jianjun Yu, Zhensheng Jia, Yonk-Kee Yeo, and Benny Bing have already demonstrated transmission of 32 wavefronts, each with 2.5 gigabit per second wireless service.

Chang has been talking with telecommunications providers about the new network architecture, and says it could be commercially available within five to seven years. But he agrees that even with many groups world-wide working on the issue, there're many technical challenges remain.

A key issue will be reducing the cost of the components. For commercial locations such as airports, hotels and convention centers, those costs could be shared by many users, Chang points out. But before the service could be cost-competitive for the home or even small-office, home office (SOHO) market, equipment costs will have to drop.

Another issue will be antenna designs for delivering high-speed wireless to specific areas of a building without interfering with service in adjoining spaces. To meet those challenges, Chang is collaborating with Manos Tentzeris and John Papapolymerou, two Georgia Tech School of Electrical and Computer Engineering professors who are also part of the Georgia Electronic Design Center (GEDC).

Chang is also working on efficient coding methods to deliver robust packets and bit streams under adverse environment such as RF blocking and fading of wireless signals inside the building. To meet these challenges, Chang is working with Faramarz Fekri, a professor in School of Electrical and Computer Engineering, to devise coding schemes that would extend the range of millimeter-wave transmission or reduce the bit error rate of transmission by intelligently using a small overhead in packets.

Companies such as NEC and BellSouth are already working on components integration and systems requirements needed for the hybrid optical-wireless communications network. Integrating the system components may be the most challenging part of the implementation and network deployment.

"We want to keep the mobility and easy of access that you find in wireless hot-spots, but we are shooting for the highest speed possible for wireless," Chang added. "The interface between the optical and wireless is critical. A lot of people are interested in this kind of research, but to make this practical, we need industry and universities working together."

Source: Georgia Institute of Technology

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