Printed Wiring Board Supporting Cloud Computing

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Cloud Computing became a familiar concept within our industry and personal use. And this gives us great convenience. The systems on which Cloud Computing is based include a network, server and storage, for which more high-speed signals must be used to send more data in a short time. The Printed Wiring Board fixes and connects LSIs and operates important functions for high-speed operation. This paper introduces the situation of the Printed Wiring Board for high-speed signals and future prospects.

The Multi Wiring Board (MWB®) is one of our products and suited for high-speed signals, because of its superior signal loss and signal delay properties. As a specific example to achieve high-speed operation, this paper introduces "High-Speed Signal MWB" and "Hybrid MWB" for networks and servers and an "Optical Waveguide" development for speed exceeding 25 Gbps, for which transmission by electrical signals is difficult.

1 Cloud Computing

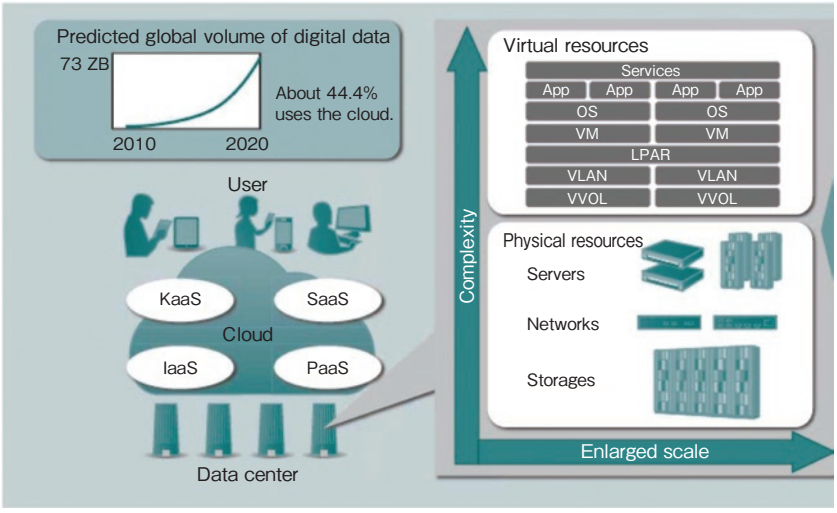
Unlike conventional independent computer systems, cloud computing proposed in 2006 connected multiple computers via a network like the Internet to offer services. Cloud computing users can obtain the necessary information or service any time without being conscious of computers. At the same time, service providers can expand or reduce their systems as required regardless of location. Its high cost performance has seen cloud computing rapidly gain popularity in recent years.

Cloud computing allows corporate users to share documents and data, and medical doctors to make immediate confirmation of cases, anytime and anywhere, through an information database at medical institutions. For private users, services include real-time downloads of news, music and video to their smartphones and tablets.

The data management facility in cloud computing is called the data center, which comprises servers for data processing, data storage, and networks for connecting the data center to the outside network.

As the cloud computing is used widely, the volume of operating data is increasing, and it is predicted that the total volume of digital data worldwide will increase to more than ten times and reach 73 ZB ($Z = 10^{21}$) by 2020[1]. High-speed signals have been required for servers, storages, and networks to deliver as much data as possible in a short time.

Printed wiring boards, used for servers, storages and networks, incorporate LSIs and other electronic components and transmits signals. Their development is therefore critical for high-speed signals, particularly servers at the center of data manipulation. We have set a signal speed target from the current 5 - 10 Gbps to 25 Gbps in 2015.



Note: Abbreviations ZB (zetta bytes), KaaS (Knowledge as a Service), SaaS (Software as a Service), PaaS (Platform as a Service), IaaS (Infrastructure as a Service), App (Application), OS (Operating System), VM (Virtual Machine), LPAR (Logical Partition), VLAN (Virtual Local Area Network), VVOL (Virtual Volume)

Figure 1 A Large-scale Cloud Data Center Operation and the Global Volume of Digital Data [1]

2 Multi Wiring Board (MWB®)

The Multi Wiring Board (MWB®) is one of the printed wiring board products of Hitachi Chemical, with a unique structure, in which wiring is formulated with insulated discrete copper wires attached to the insulating board. Conventional printed wiring boards makes circuits by selective etching of copper foil with chemical agents. **Figure 2** shows the surface and cross-sectional photos of the wiring layer on the MWB. Compared with conventional printed wiring boards, the MWB using copper wires with smooth surface has good high frequency properties with small propagation loss of high frequency signals. **Figure 3** shows a comparison of the propagation loss of a conventional multi layer wiring board and MWB. Because of using insulated wires and cross wiring, MWB has high insulation reliability and high density wiring.

Production of the MWB started in 1973, since which time the MWB has been used for supercomputers, LSI inspection systems, aerospace and various other industries and supported industrial development.

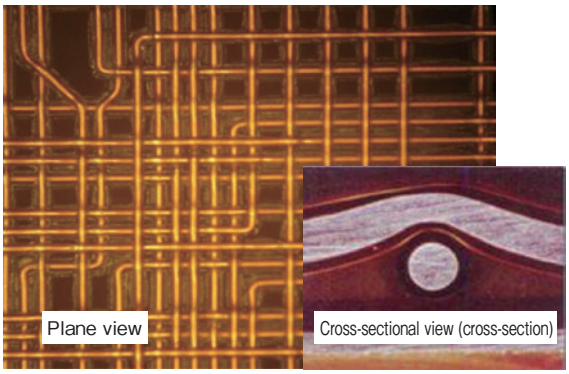


Figure 2 Wiring Layer for Multi Wiring Board

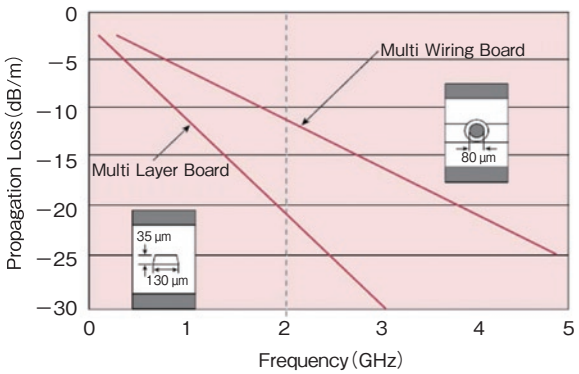
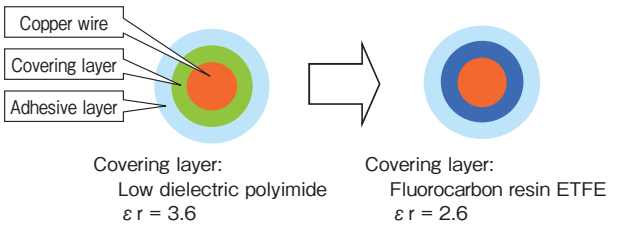


Figure 3 Comparison of Propagation Loss

3 MWB for High-Speed Signals (under development)

We set 25 Gbps as the target internal signal speed for next-generation servers by 2015 to respond effectively to a required communication speed of 100 Gbps, a hundred times faster than now. A printed wiring board with signal propagation loss of less than 0.6 dB/inch at 12.5 GHz is required to achieve this target. The target is also considered to represent the limit of electric signals in practical terms, since more electric energy turns to electromagnetic waves for attenuation with increasing frequency. **Figure 4** shows the cross-sectional structures of wires mounted on the MWB for high-speed signal transmission designed for achieving the target, and **Figure 5** shows the simulation results of signal propagation loss.

We have developed an MWB with configuration to improve signal propagation loss using ETFE featuring effective high-frequency properties as the insulated covering material of wires, and keeping high density wiring. The product will be marketed by 2014; targeting application as a back board with the longest transmission distance among the components of next-generation servers.



Note: Abbreviation: ETFE (tetrafluoroethylene and ethylene copolymer)

Figure 4 Improvement in Electrical Performance by Changing the Covering Material

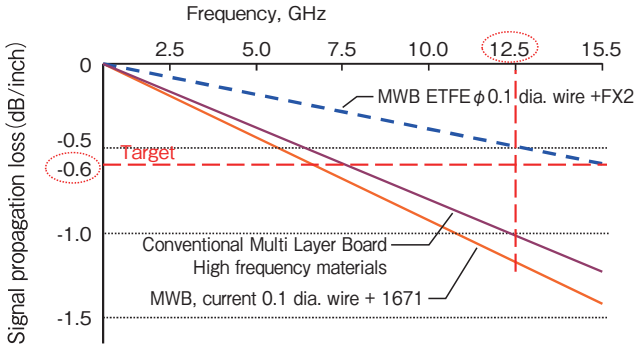


Figure 5 Signal Propagation Loss Simulation by Current and ETFE Wires

4 Hybrid MWB

Despite its effective electrical properties, MWB has relatively low productivity, since the insulated copper wires need to be attached to the insulating plate one by one using an NC machine. To improve productivity, we developed the Hybrid MWB Type 2, which comprises a conventional wiring board for general wiring and MWB for wiring high-speed signals. We also developed the Hybrid MWB Type 3, for which a fine-pitch circuit board is mounted on the MWB to achieve fine pitch assembly of surface mounted components. **Figure 6** shows example cross-sectional structures of Hybrid MWB Type 2 and Type 3.

Hybrid MWB Type 2 and Type 3 have already been mass produced in 2012, and applied to semiconductor inspection systems, servers and network equipment.

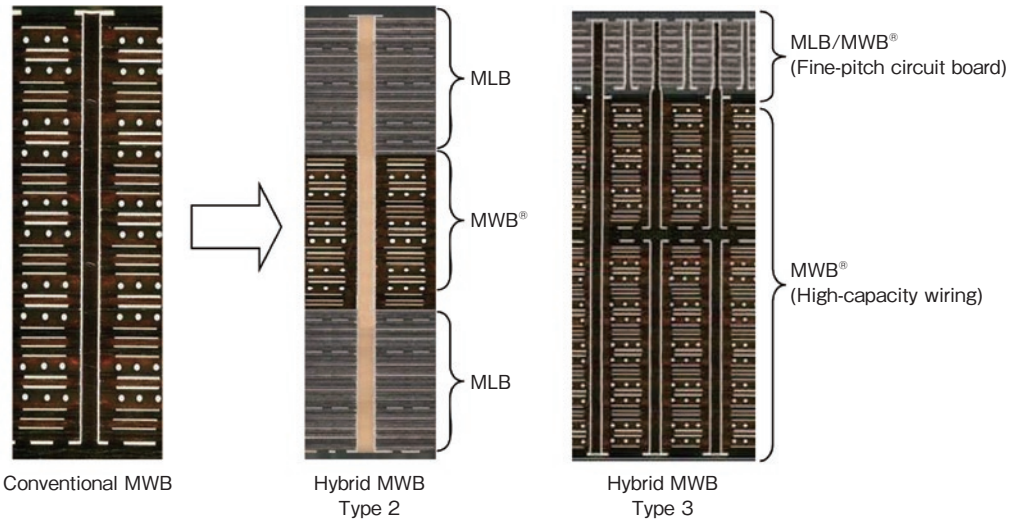


Figure 6 Hybrid MWB Cross Sections (Example)

5 Coaxial MWB, Optical Wiring Board (under development)

25 Gpbs is considered to be the limit of practically feasible electric signals due to propagation loss. To achieve signal speed exceeding 25 Gbps, we are developing Coaxial MWB using coaxial wires for electric signals and Optical Wiring Board using on-board optical waveguide for optical signals. **Figure 7** shows the relationship between signal speed and wiring capacity, and **Figure 8** shows an example of optical waveguide substrate under development. These products and technologies are under development to be used for next-generation cloud computing equipment such as servers and networks after 2016.

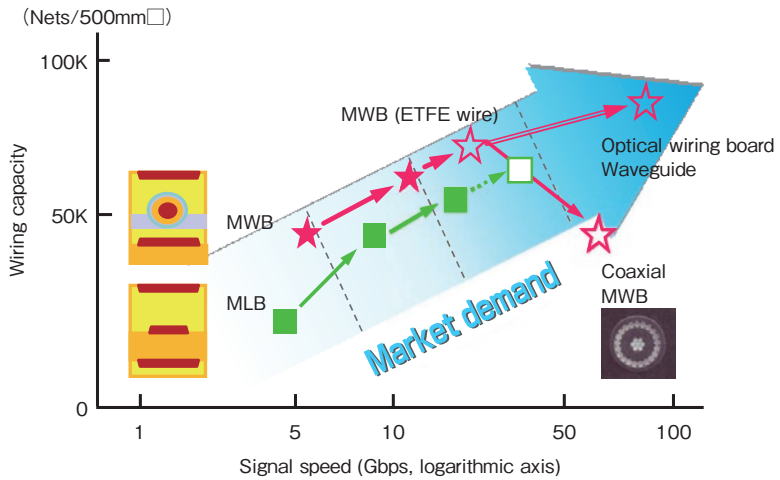


Figure 7 Improvement in Signal Speed and Wiring Capacity for Each Printed Wiring Board

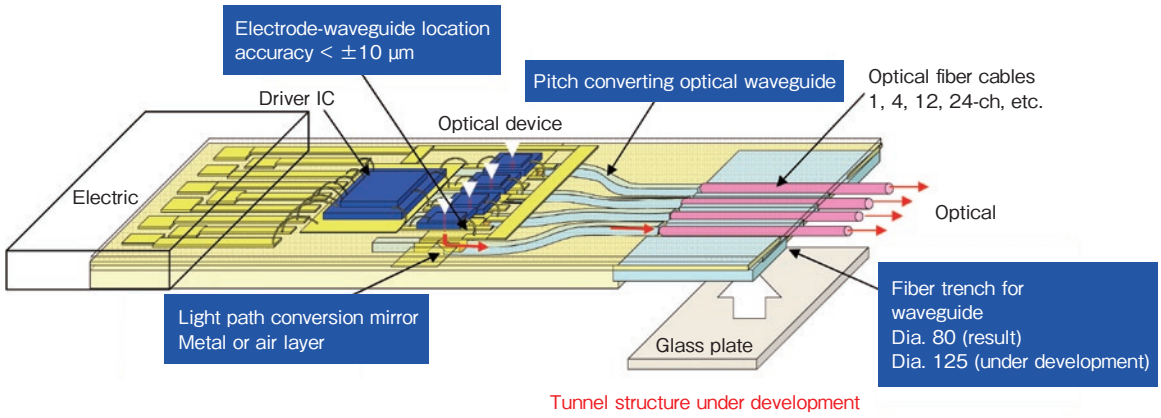


Figure 8 Developed Optical Waveguide Substrate Example

6 Conclusion

With the progress of cloud computing, we are in an age when big sized data can be used anytime and anywhere. The evolution of cloud computing is expected to accelerate in future, and the requirement for high speed signals in printed wiring board also accelerate. Hitachi Chemical will lead these movements by developing innovative technology and products based on MWB to meet customers' expectations.

【References】

1) Yukinori Sakashita, Yutaka Kudo, Masataka Nagura, Takato Kusama, IT Resource Management Technology for Operation Expense Reduction in Cloud Data Center, Hitachi Review Vol. 94, No. 04 352-353, pp.54-57 2012.04
2) Takehisa Sakurai, Masahiro Kato IEEE Semiconductor Wafer Test Workshop 5-16-2012 2012.6