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Comparison of Physical Network Configurations for Next Generation Home Network

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Abstract- Physical network configurations for the next generation home network are compared in terms of total cable length by considering the general house model. Longest distance between the router and optical wall socket is also discussed by using typical numerical values of Japanese houses.

1. Introduction

The next generation home network will accommodate several different kinds of terminal or appliances with large capacity links [1]. One of the heaviest bandwidth consumers is the audio visual (AV) terminal; its traffic is heavy and bursty. Therefore, the transmission medium used must offer very wide bandwidth. Optical fiber is the most promising candidate. However, actual installation guidelines of optical fiber cables have not been well discussed.

The authors have already presented the basic house model for evaluating cable length in a home [2].

This paper extends the basic model to yield a more realistic solution; Cable wiring routes that replicate those in actual homes are considered. Four optical wall sockets are also considered. This paper also describes total cable length and the longest length for three network topologies.

2. Cable wiring route in a home

Network topologies considered here are single star, double star, and ring. Wiring routes are considered using the housing model shown in Fig. 1 and Fig. 2 where a house consists of multiple boxes stacked with each size of *a* x *b* x *c* [2]. Four optical wall sockets locate each at the four corner of each room.

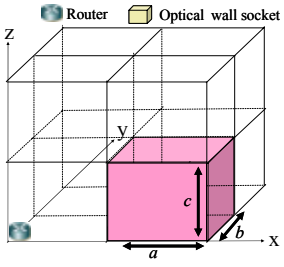

Fig. 1 Housing model

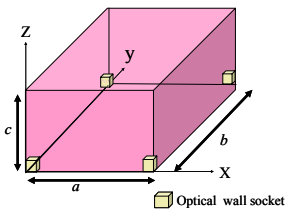

Fig. 2 Room model

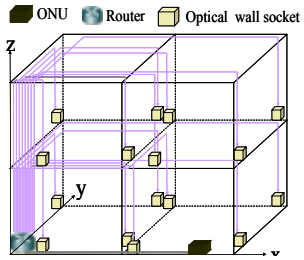

Fig. 3(a) Wiring route of single star configuration

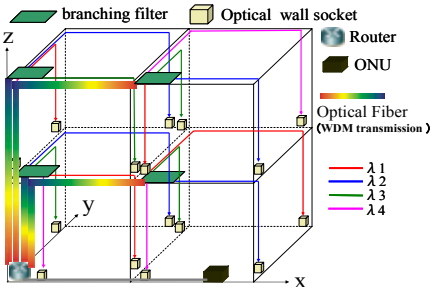

Fig. 3(b) Wiring route of double star configuration

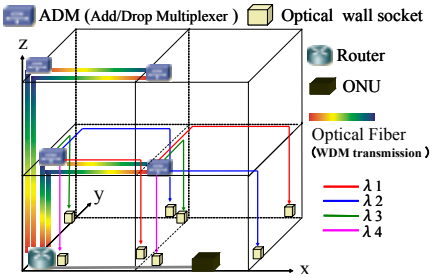

Fig. 3(c) Wiring route of ring configuration

Figure 3 shows the wiring route of each network topology; (a) single star, (b) double star, (c) a ring. It is also assumed that each room has a branching filter and ADM (Add/Drop Multiplexer) in the ceiling (left corner). Moreover, the double star and the ring utilize WDM (Wavelength Division Multiplexing) technology for signal multiplexing. The ring type is structured as one ring per floor.

3. Total cable length needed for each network topology

The assumed room size is as shown in Fig. 2, a = x-axis, b = y-axis and c = z-axis. The house has F floors.

Total wiring length L is given by $L=L_1+L_2+...+L_f$ where L_f means total cable length on the fth floor with number of rooms N_{fx} on the x-axis and N_{fy} on the y-axis.

3.1 Total wiring length formula for calculation

i) L_f for the single star is given by $L_f=L_{fx}+L_{fy}+L_{fz}$. L_{fx}, L_{fy}, and L_{fz} denote the cable length on the x, y, and z axis, respectively; N_f corresponds to the number of rooms on the fth floor.

L_f is given as (1);

$$L_f = \sum_{i=1}^{Nfx}\{2a+4a(i-1)\}\times N_{fy} + \sum_{j=1}^{Nfy}\{2b+4b(j-1)\}\times N_{fx} + \{8N_f+4(f-1)N_f\}\times c \quad (1)$$

ii) L_f for the double star is given by $L_f = (L_{fx}+L_{fy}+L_{fz}) + N_f\, l$ where l denotes the cable length between branching filter and optical wall socket per room. This value is fixed here to $l=2a+2b+4c$.

L_f is given as (2);

$$L_f = \sum_{i=1}^{Nfx}(i-1)a\times N_{fy} + \sum_{j=1}^{Nfy}(j-1)b\times N_{fx} + fN_fc + N_fl \quad (2)$$

iii) L_f for the ring is given by $L_f = (L_{fx}+L_{fy}+L_{fz}) + N_f l$ where l denotes the cable length between ADM and optical wall socket per room. This value is also fixed to $l=2a+2b+4c$. L_f depends on the values of N_x and N_y as follows in eqs.(3) to (7);

Case 1) N_x < or =3

N_x=1、N_y>1 $L_f=2(N_y\text{-}1)b+2fc+N_f l$ (3)

N_x=2、N_y>1 $L_f=2a+2(N_y\text{-}1)b+2fc+N_f l$ (4)

N_x=3、N_y>1 $L_f=4a+(4N_y\text{-}6)b+2fc+N_f l$ (5)

Case2) N_x > or =4 and N_x is an even number

N_x=4、N_y>1 $L_f=6a+(4Ny\text{-}6)b+2fc+N_f l$ (6)

Case 3) N_x > or =4 and N_x is an odd number

N_x=5、N_y>1 $L_f=8a+(6Ny\text{-}10)b+2fc+N_f l$ (7)

3.2 Comparison of total cable length for the network topologies

For comparing the three topologies in terms of total cable length, several parameters are set such as; a=1, b=1, c=1, Nx=3, Ny>1, and F=2. Figure 4 shows total cable length vs. Ny with parameters set before for each topology. It is observed that the ring has shortest length and the single star has about twice the length of the others.

4 Calculation of longest transmission distance for the network topologies

The longest transmission distance in each network topology is derived by using the mean values of houses in Japan [3]. These values are;

- size of room (Refer to Fig. 2); a=4.5m, b=4.5m, c=2.4m,
- number of floors: F ; two floors, and
- number of rooms on one floor; four rooms, Nx=2, Ny=2.

The longest distance from the router to an optical wall socket in the single star is 25.2m. Here, six bends and six connectors are assumed.

The longest distance from the double star type router to an optical wall socket is 25.2m. This value is the same as that of single star; basic configuration is the same except that the double star has a branching filter between the router and the optical wall socket. Thus four bends and eight connectors are assumed. Signal passes through a branching filter in this configuration.

The longest distance from the ring type router to the optical wall socket is 29.7m. Thus four bends and fourteen connectors are assumed. In this configuration, the signal passes through four ADMs.

As a result, the ring type has the longest distance. Moreover, the transmission loss might be large because many connectors and ADMs are needed.

5. Conclusion

This paper examined the wiring routes likely for the next generation home network. Total wiring length of three basic network topologies was compared. The longest distance in each network topology between a router and optical wall socket was elucidated by using the average value of Japanese houses. We found that the double star appears to be the optimal configuration for the next generation home network.

Cable installation trials in actual houses are needed determine real-world optical budgets.

References

[1] K. Oguchi, K. Tojo, T. Okodo, Y. Tsuchida, T. Yamaguchi, and T. Murooka, "Next generation home networking and relevant technologies" Proc. SPIE Vol.5656, Network Architectures, Management, and Applications II, pp. 163-168, Feb.2005

[2] K. Oguchi, T. Okodo, K. Tojo and K. Okada, "Physical network configuration of next generation home network", OFCNFOEC2006, Anaheim, CA, March 5-10, 2006

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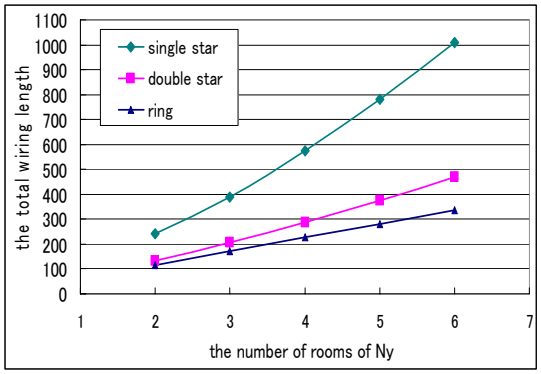

Fig. 4 Total wiring length comparison