High-density Modulation Technology for Digital Cable TV Transmission

Takuya KURAKAKE,
Digital Broadcasting Networks

I joined NHK Science & Technical Research Laboratories in 1994 and have researched digital cable television systems and optical transmission technologies. My recent research interests include transmission technologies for large-capacity digital cable television systems. I am now engaged in the development of reception techniques for 1024-QAM cable transmission.

The number of Japanese households that subscribe to cable TV service reached 15.14 million as of the beginning of fiscal 2004, showing that cable TV is becoming important as an information infrastructure.

Current digital services offered via cable TV network use the 64QAM modulation[1] scheme, transmitting data at approximately 29 Mbps over a 6-MHz bandwidth. This means that data at 52.17 Mbps for one digital Broadcasting Satellite (BS) transponder needs to be re-transmitted over two cable TV channels. Faster data transfer speeds over cable TV networks in which digital BS service can be retransmitted using only one channel could let even cable TV facilities with a tight channel allocation transmit a large number of digital broadcasting services.

For this reason, we devised a transmission scheme that can transmit data for one digital BS transponder over a single cable TV channel. This high-density modulation scheme is called 1024QAM, an extended version of the standardized 64QAM scheme.

Cable TV signals may be degraded by inter-symbol interference, caused by reflection due to mismatched impedances. The 1024QAM scheme, with a high-density constellation, as shown in Figure 1, requires a higher performance equalization technology to reduce interference. Although a method to utilize a known training signal, inserting it at regular intervals, is effective for equalization, it has the disadvantage of reducing the transmittable data amount.

With the aim of attaining expanded capacity, we have developed an equalization method for 1024QAM transmissions without the use of training signals and have evaluated the modem performance with different transmission parameters including a 4% roll-off factor. Based on the results, a prototype 1024QAM receiver has been developed (Figure 2). A system that incorporated this prototype demodulator achieved a bit rate of approximately 53 Mbps. It also adopted Reed-Solomon code (204,188) for error correction in conformance with existing digital broadcasting systems.

Laboratory experiments revealed that the reception CN ratio was 38 dB to obtain a pre-error-correction bit error rate (BER) of 10^{-4}, which is a requirement for digital broadcasting to be quasi-error-free after error correction. This means the prototype demodulator achieved this BER at about a 2 dB degradation from the theoretical value.

Using this prototype, an experiment was conducted at an actual cable TV transmission facility[2]. The 1024QAM power is equivalent to that of analog VSB-AM signals. Measurements at subscriber's premises showed that data rates for a digital BS broadcasting transponder can be achieved at a single 6-MHz cable TV channel.

Future work will involve clarification of the performance characteristics required for the transmission facility and receiver and resolution of the remaining issues for implementation.

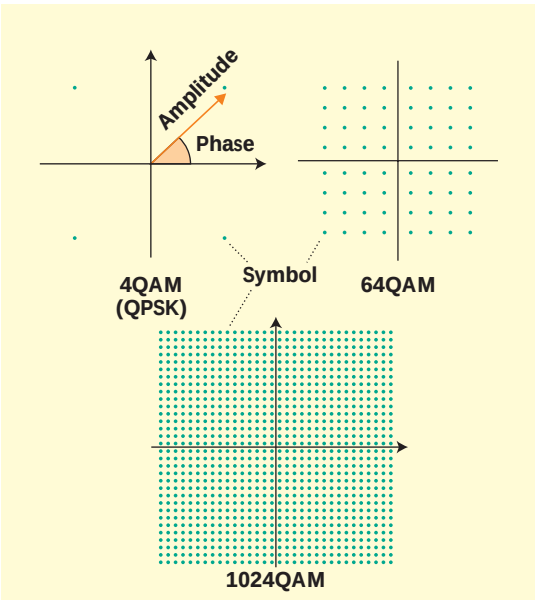

Figure 1: Symbol constellation for various QAM schemes

Figure 2: Prototype 1024QAM demodulator

[1] QAM (Quadrature Amplitude Modulation): a digital modulation scheme that transmits data with amplitude and phase.

[2] This experiment was conducted with the cooperation of the LCV Corporation.