Start of Transmission from Tokyo Skytree

—*Part 3: Relocation Measures*—

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1. Relocation measures

At 9 am on 31 May 2013, the master station used for terrestrial digital TV broadcasting in Tokyo by NHK and five private broadcasting companies (with a reach of some 15 million households) was relocated from the Tokyo Tower to the Tokyo Skytree. This relocation took place during normal broadcasting without changing channels, and proceeded smoothly and without major incident due to the prior application of diverse studies, safeguard measures and common knowledge to ensure that signals could be received from both stations.

2. Deployment of countermeasures

To ensure the relocation went smoothly, six companies in the Kanto region set up the Tokyo Skytree Transition Center (T-SAPO) in July 2011. This center liaised with call centers, general market researchers and industries to promote various studies and countermeasures.

3. Advance simulation

Although the network for transmissions from the Tokyo Tower is currently complete, differences in electric field values arose due to differences in the transmitter specifications and differences in lag times due to the effect of the relocation on the positional relationships of relay stations.

These relocation effects were estimated in a simulation. First, the study area was divided into a mesh of approximately 1 km square blocks, and a radio propagation simulator was used to calculate the field strength of all transmitting stations. A single frequency network (SFN) was then used to study the effects of all the stations in each area, and the effects of transmissions in the same channels by other stations outside the broadcast region. The effects of boosters installed on receiver equipment were also studied in a simulator. Furthermore, in the vicinity of the transmitter where there is a strong electric field, we simulated the effects of adding or removing obstacles for all buildings in the area, using data on the shape and height of buildings.

4. Optimization of transmission delay time

To minimize SFN failures caused by exceeding the guard interval around the time of the relocation, an optimal delay time was determined for each relay station, and advance modifications were made at 65 of these (approximately one third of the total number of relay stations). This made it possible to greatly reduce the number of households affected by interference in the Kanto region.

5. Launch of experimental test station

An effective way of studying the effects of relocation is to perform measurements in which test waves are actually transmitted. However, considering the effects on broadcast radio waves in the same area and in other regions, we were somewhat constrained by having to confine these emissions to periods when other broadcasts are off the air. We therefore launched an experimental test station for the purpose of estimating the behavior of OFDM waves emitted from the Tokyo Skytree as low-power single carrier waves (CW) in the intervals between transmitted signals (OFDM waves). This enabled us to figure out if there would be any effects by using estimated values calculated from the CW measurement values, even during ordinary broadcast time slots.

6. Preliminary survey measures

In places that were expected to be affected by the relocation, we first surveyed the reception patterns so as to exclude areas using other means of reception such as CATV, and we adjusted the measurement points accordingly. In the survey, we measured the desired station, broadcast waves from the Tokyo Tower, and a CW signal from the Tokyo Skytree. In cases where it was not possible to estimate the propagation effects with a CW signal alone due to multipath effects, measurements were performed by emitting OFDM test waveforms at nighttime during inactive periods in order to determine in advance the measures required.

A measurement survey was performed for each facility where it was found that the electric field increased or decreased significantly according to the simulation results for each building. Furthermore, in areas where there were inferred to be new concentrations of facilities in the shadow of other buildings, a C/N continuous measurement system incorporating a car-mounted TV tuner and GPS device was used to confirm the changes in reception status from both towers, and measurements were performed individually if necessary. Based on the results of these measurements, advance measures were implemented where necessary.

7. Measures implemented based on monitor surveys and reception confirmation tests

Monitor tests were performed centered around large-scale apartment blocks where the relocation was expected to have a large effect. These tests involved checking nighttime test broadcasts and implementing advance measures at facilities that were judged to be inadequate. Next, we performed reception confirmation tests to elicit statements from households experiencing poor reception when switching over to the Tokyo Skytree during broadcasting. These started in early morning time slots, and were gradually shifted towards time slots with higher viewing figures. The tests were performed 128 times before the cutover, and a series of measures was implemented at facilities where reports had been made.

A call center was opened at about the same time as the initial test wave transmissions. This call center was staffed by up to 260 operators at peak times around the time of the migration.

Knowledge of the reception confirmation tests became widespread due to publicity in broadcast programs, websites, newspapers, train advertising and the like, with the result that a questionnaire conducted at the end of March found that approximately 75% of respondents had viewed these tests.

8. Post cut-over support

On 31st May, the relocation went ahead as planned. At its peak, the work to implement countermeasures was being carried out by 1,000 crews, and was completed without any major disruption.

We are currently conducting long-term radio wave measurements at 16 locations in Tokyo and the surrounding regions, and are implementing anti-fading measures.