Arrival angular characteristics at low base station facing the street in Micro Cell for Mobile Communications

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Abstract **–The arrival angular profile prediction formula at base station (BS) is necessary in order to assess spatial processing technologies such as MIMO (Multi-Input Multi-Output) techniques. In previous works, we proposed an empirical arrival angular profile model at BS in macro cells (Macro-cell arrival angular profile model) where the BS height is higher than the average building height in its coverage area. However, this macro-cell model is invalid for micro cells where BS height is lower than the average building height in its coverage area. In this paper, we measure the arrival angular profile at low BS facing the street and clarify the characteristics of arrival angle.**

Index Terms **— propagation, Arrival angular profile, Time-Spatial profile.**

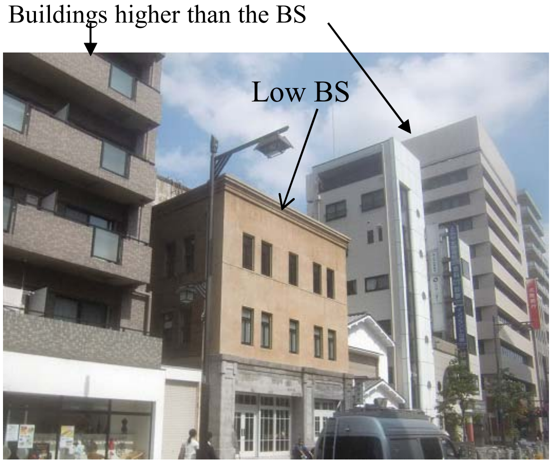
1. Introduction

In order to develop higher capacity cellular systems, system design must consider both the frequency characteristics in the transmission band and the spatial characteristics between transmitter and receiver antennas. These characteristics can be determined by a time-spatial propagation (TSP) model that addresses both the delay profile and arrival angular profiles at both base station (BS) and mobile station (MS) at the same time.

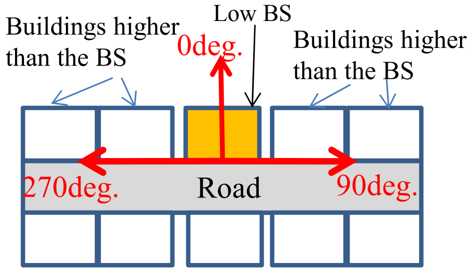
Recently, small cells such as micro and pico cells, whose base station (BS) antennas are generally installed at heights below those of neighbouring buildings, are being introduced in order to suppress co-channel interference. Thus, a TSP model for low-antenna-height BSs in the UHF and the SHF bands is strongly required.

In previous works, we proposed an empirical arrival angular profile model at BS in macro cells (Macro-cell arrival angular profile model) where the BS height is higher than the average building height in its coverage area [1],[2]. However, this macro-cell model is invalid for micro cells where BS height is lower than the average building height in its coverage area [3].

In this paper, we measure the arrival angular profile at low BS facing the street and clarify the characteristics of arrival angle.



(a) The photo of BS's surroundings



(b) The map of BS's surroundings
Fig. 1. Measurement environments

2. Field measurement

We carried out field measurements of arrival angular profile at a BS of a micro cell in a typical urban area in Tokyo; the average building height is 25m. Fig.1 shows a photo and map of the BS's surroundings. As shown in this photo, the BS facing the street and next buildings are both higher than the BS. The directions of road are 90 degrees and 270 degrees. The directions between 90 degrees to 270 degrees are directions between the buildings and facing the road.

Table 1 shows the field measurement parameters. The BS antenna height, h_b, was 15m. The frequency, f, were 1.5GHz,

TABLE I
Measurement parameters

Frequency		1.5GHz(CW), 3.3GHz(50Mcps), 5.2GHz(50Mcps)
Transmitting power		10W
BS	Antenna	The directional antenna (half-band width :8 degrees(1.5G), 3 degrees(3.3G, 5.2G))
	Antenna height	15m
MS	Antenna	Sleeve antenna (Omni-directional)
	Antenna height	3m
Average building height		25m

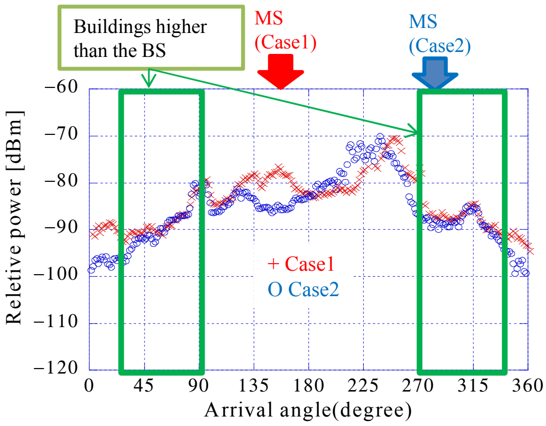


Fig. 2. Examples of measured arrival angular profile : f=3.3GHz

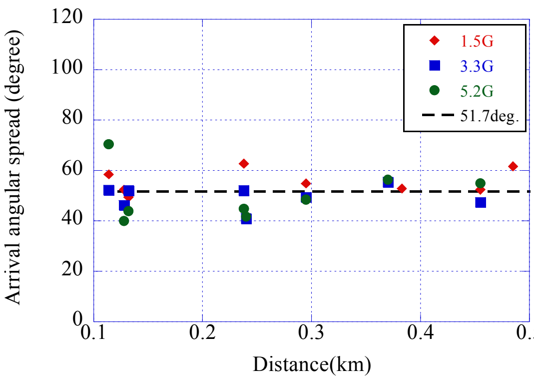


Fig. 3. Arrival angular spread

3.3GHz and 5.2GHz. We used the narrowband carrier wave for f=1.5GHz. On the other hand, the chip rate, B of f=3.3GHz, 5.2GHz, were 50M chips per second.

The transmitter and receiver were placed in a van and on a building respectively. The omni directional antenna for the transmitter antennas were mounted on the rooftop of the van. The directional antenna with half beam width of 8 degrees for f=1.5GHz and 3 degrees for f=3.3GHz, 5.2GHz for the receiver antenna were placed on the top of the building. We measured the arrival angular profile at BS by rotating the directional antenna for f=1.5GHz on the top of the building. Also we measured the delay profiles at 3 degree intervals by rotating the directional antenna for f=3.3GHz and 5.2GHz on the top of the building. The arrival angular profile at the BS for f=3.3GHz and 5.2GHz were obtained by summing each delay path's power at each angle. Therefore, these profiles are the same as the arrival angular profile that would be measured by using a narrowband carrier wave. The measurement routes were selected in NLOS areas ranging from 0.1km to 0.5 km (radius) from the BS.

3. The arrival angular characteristic at low BS facing the street

Fig.2 shows examples of the measured arrival angular profiles for f=3.3GHz. The green square boxes show the directions of the two buildings next to the BS, see Fig. 1. In Fig. 2, there are two measured cases. The MS lies on a line that runs between two of the buildings (Case 1) and the MS lies on a line to one of the two buildings (Case 2). From these results it is found that the received power from the directions of buildings higher than the BS next to the BS is smaller than from the directions between 90 degrees to 270 degrees and that this doesn't depend on the orientation of the MS.

Fig.3 shows the arrival angular spread at each measurement point. From this figure, the micro cell arrival angular spread doesn't depend on the distance between BS and MS and the value of arrival angular spread is about 40 to 70 degrees. Also the mean values of arrival angular spreads for f=1.5GHz, 3.3GHz and 5.2GHz are 53degrees, 50degrees and 51degrees, respectively. There is no significant difference between using different frequencies. Fig.3 also shows the mean value of arrival angular spreads for all measured result; 51.7degrees. It is indicated that the arrival angular characteristic at low BS facing the road doesn't depend on the distance or frequency.

4. Conclusion

In this paper, we measure the arrival angular profile at low BS facing the street. From the measured results, it is indicated that the arrival angular characteristic at low BS facing the road doesn't depend on the distance or frequency.

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