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STC mode of operation in an OFDMA SFN environment

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1. Introduction

The following contribution brings the details of the STC operation of the OFDMA system in a SFN environment. The configuration brought in this contribution allows seamless interoperability between the mandated and the optional STC mode in an SFN deployment.

The following section replaces section 8.5.10.6

8.5.10.6 Transmit diversity: Space-Time Coding (optional)

Space-Time Coding (STC) (see [B26]) may be used on the downlink to provide 2nd order (Space) transmit diversity.

There are two transmit antennas on the BS side and one reception antenna on the SS side. This scheme requires multiple input single output channel estimation. Decoding is very similar to maximum ratio combining.

Figure 128bo12 shows STC insertion into the OFDM chain. Each Tx antenna has its own OFDM chain, but they have the same Local Oscillator for synchronization purposes.

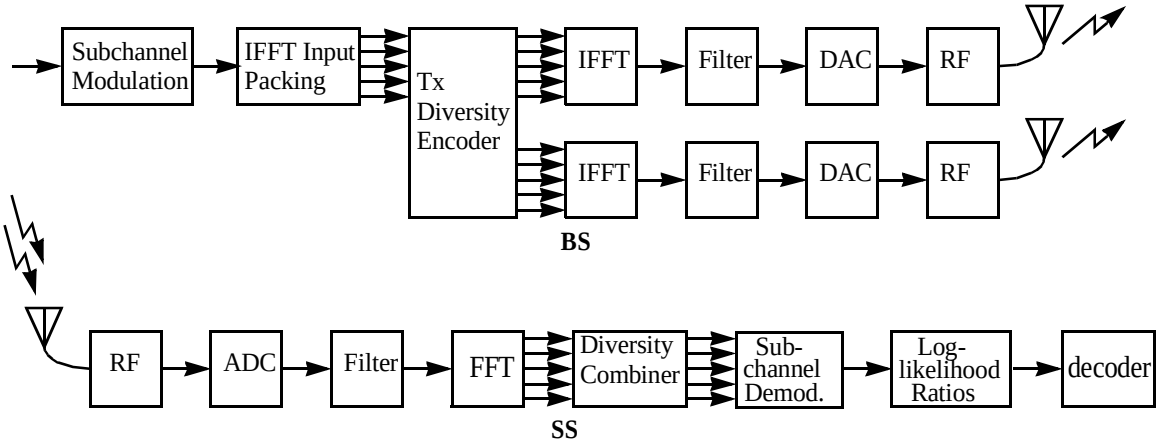

Figure 128bo12—Illustration of STC

Both antennas transmit in the same time 2 different OFDM data symbols. Transmission is performed twice to decode and to get 2nd order diversity. Time domain (Space-Time) repetition is used.

This mode of operation allows better performance with higher complexity in the receiver. The mode of operation introduced in the sequel defines a combined operation of the STC and the mandatory mode. The current SFN mandatory mode of operation allows the splitting of the available Sub-Channels into 3 sectors, each transmitting some of the Sub-Channels as allocated by the system management. The STC mode of operation shall be used in a combined way with the regular mode of operation by using it's own allocated set of Sub-Channels, this will result in a possible splitting of the Sub-Channels to 6 different allocations:

— Allocations for regular use
— Allocations for STC use

The regular Sub-Channel transmission in the downlink shall be performed from only one antenna (Antenna 0) while the STC Sub-Channels transmission shall be performed from both antennas obeying the formulas in 8.5.10.6.1.

8.5.10.6.1 Multiple in single out channel estimation and synchronization

Both antennas transmit in the same time, and they share the same Local Oscillator. Thus, the received signal has exactly the same auto-correlation properties as for a single antenna. So, time and frequency coarse and fine estimation can be performed in the same way as for a single antenna. The scheme requires multiple input single output channel estimation, which is allowed by splitting some preambles and pilots between the 2 Tx antennas, as described in 8.5.10.6.1.

8.5.10.6.1.1 STC encoding

The basic scheme [B26] transmits 2 complex symbols s_1 and s_2, using the multiple input single output channel (two Tx, one Rx) twice with channel vector values h_0 (for antenna 0) and h_1 (for antenna 1).

First channel use: Antenna0 transmits s_1, antenna1 transmits s_2.

Second channel use: Antenna0 transmits $-s_2^*$, antenna1 transmits s_1^*.

Receiver gets r_0 (first channel use) and r_1 (second channel use) and computes s_1 and s_2 estimates:

$$\hat{s}_1 = h_0^* \cdot r_0 + h_1 \cdot r_1^* \quad (1)$$

$$\hat{s}_2 = h_1^* \cdot r_0 - h_0 \cdot r_1^* \quad (2)$$

These estimates benefit from 2nd order diversity as in the 1Tx-2Rx Maximum Ratio Combining scheme. The downlink preamble will be transmitted for the duration of one OFDM symbol from both antennas, and subchannels used for STC are transmitted in pairs of OFDM symbols. (Equivalently, 2 Tx symbol duration is twice 1 Tx symbol duration, with twice more data in a symbol.).

Figure 128bo13 shows STC for OFDMA. Note that since pilot positions do not change from even to odd symbols, and pilot modulation is real, conjugation (and inversion) can be applied to a whole symbol (possibly in the time domain).

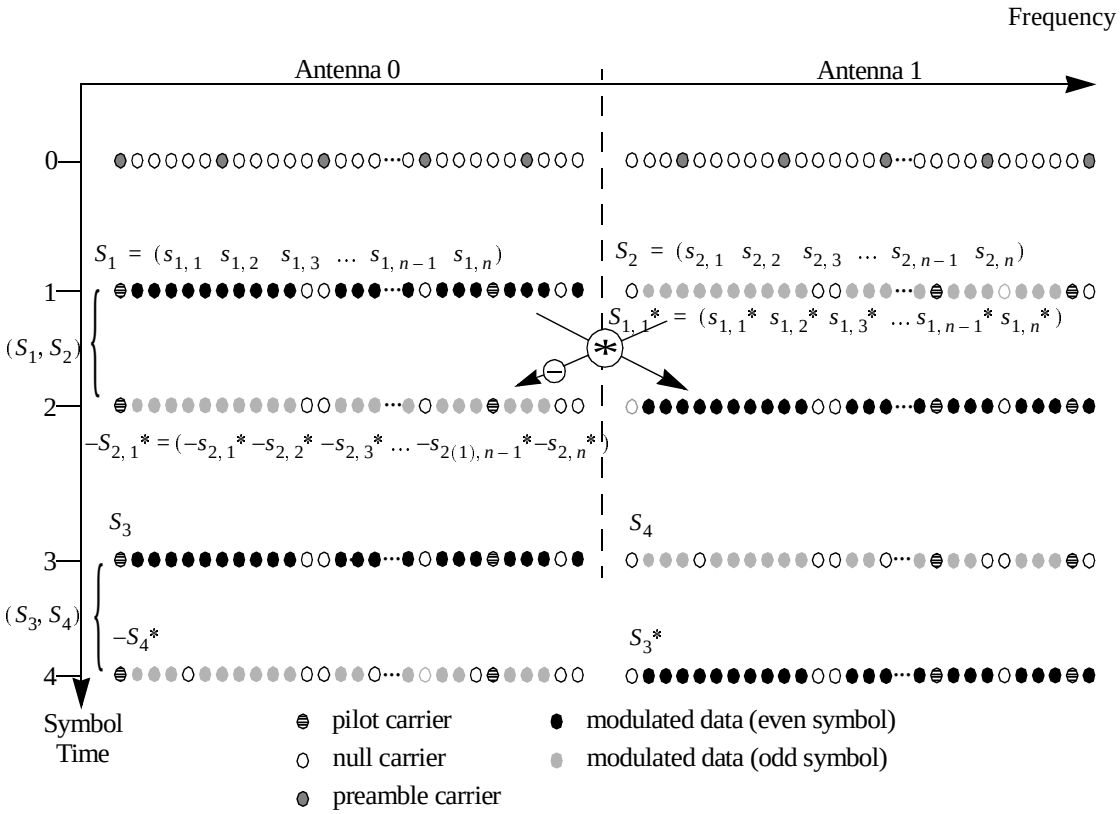

Figure 128bo13— STC usage with OFDMA

8.5.10.6.1.2 STC decoding

The receiver waits for 2 data symbols, and combines them on a carrier basis according to Equation (1) and Equation (2) in 8.5.10.6.1.1. The preamble transmitted from each antenna

8.5.10.6.2 Downlink

The downlink shall enable the co-transmission of regular Sub-Channel transmission and STC Sub-Channel transmission as explained in 8.5.10.6. The minimal allocation of sub-channels for a sector (if the sector is used) is 3 sub-chan-

nels. The first three transmitted sub-channels in the first data symbol of the DL conatins the FCH as defined in 8.5.4.2. For sector 1 Sub-channels 3-4 are used as the basic allocated Sub-Channels, for Sector 2 Sub-channels 14-16, for sector 3 Sub-channels 25-27.

In the following figure the structure of the DL Frame-Prefix Sub-Channel allocation (for the combined operation of STC and regular transmission) is shown:

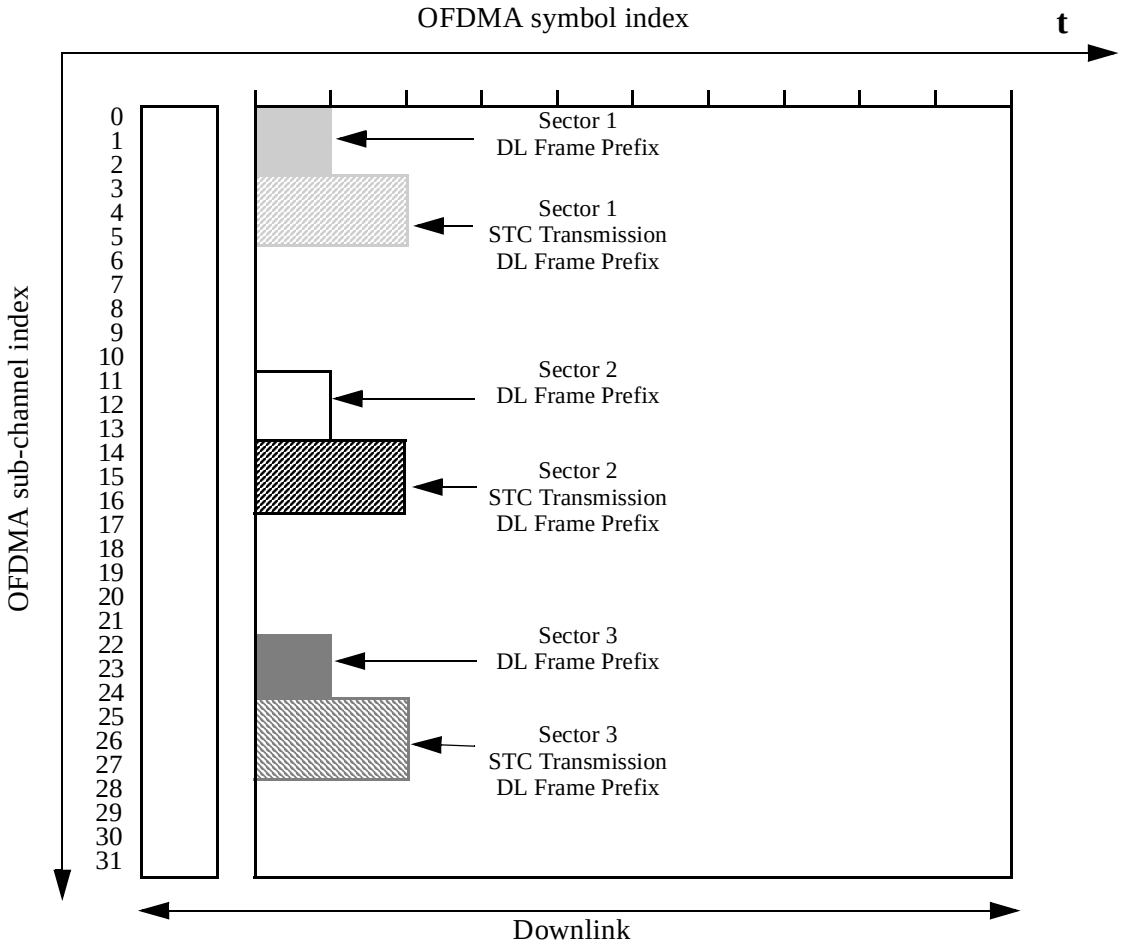

Figure 128bo14—DL Frame Prefix sub-channel allocation for the combined operation of STC and non-STC transmission

8.5.10.6.2.1 Preamble

For each sector as defined in previous sections, two antennas are used to transmit the STC signal. Therefore from the definition in section 8.5.10.3.1, the following applies:

Each sector uses 2 types of preamble (one for each antenna) out of the 6 sets in the following manner:

— Sector 1 - preamble 0 used by antenna 0, preamble 3 used by antenna 1
— Sector 2 - preamble 1 used by antenna 0, preamble 4 used by antenna 1

— Sector 3 - preamble 2 used by antenna 0, preamble 5 used by antenna 1

The same PN series as defined in that section is also used in the STC mode.

8.5.10.6.2.2 Symbol Structure

The same symbol structure defined in sections 8.5.10.3.1 and 8.5.10.3.2 shall apply for the STC mode, the amount of pilots allocated to each antenna and their details are also specified in that section (antenna shall use a subset of the pilots used by the sector).

Sub-Channels allocated to non-STC users shall be transmitted by Antenna 0 only, while Sub-Channels that are allocated to STC use shall be transmitted from both antennas.

8.5.10.6.3 Uplink

Not changed compared to the regular mode of operation.

8.5.10.6.4 Base-Band Processing

Not changed compared to the regular mode of operation.