Roads of MIMO Broadcasting: An Overview of Variant Technologies

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***Abstract*—This paper outlines futuristic ATSC 3.0 multiple-input multiple-output (MIMO) broadcasting technologies in terms of three variants: 1) Frequency reuse-1 MIMO, 2) Backward-compatible MIMO, and 3) Channel-bonded MIMO. Through a brief discussion of their principles, features, and use cases, this paper sheds light on the diverse paths of MIMO broadcasting paved for the future of digital broadcasting systems. Furthermore, the paper discusses the implications and potential advancements of these technologies, emphasizing their role in achieving higher data rates and improved flexibility.**

***Index Terms*—MIMO broadcasting, ATSC 3.0, reuse-1 MIMO, backward compatible MIMO, channel bonding.**

I. Introduction

LATELY, the actual services of the new digital terrestrial broadcasting standard, Advanced Television Systems Committee (ATSC) 3.0, have been commenced in several countries [1]. As a start-off for this new-generation broadcasting ecosystem, the launches in the United States and South Korea have departed from a generic single-input single-output (SISO) topology [2]. Since such baseline deployment has been brought into reality, pivoting from this milestone, the broadcast community is promptly preparing for the next step.

Distributing multiple-input multiple-output (MIMO) is recognized as one of the possible directions. The standard suite of ATSC 3.0 has already included MIMO operations and defined the concrete system chain [3]. This inclusion has primarily been for increased data capacity, where it doubles the transmission channel in a naïve sense. The ATSC 3.0 MIMO physically relies on cross-polarization, and stationary environments with well-pivoted directional antennas will be its primary target use case [4].

As mentioned, the first aim of building such MIMO technology has been at capacity doubling, which will bring more rich media quality or a diversified array of content [5]. However, the world is encountering greatly divergent local situations, which seek different values or are constrained differently by unique states of affairs. Such diversity, as a consequence, necessitates dedicated system evolutions into variant forms.

In this paper, we introduce the evolutions of MIMO broadcasting technology on the ATSC 3.0 basis, also enlightening the particular need, use cases, and the background behind them. This report starts from a *reuse-1 MIMO,* which is currently a special interest of the Brazilian broadcasting community, and continues with *backward compatible (B-Comp) MIMO* and *channel-bonded (CB) MIMO* that have emerged from other contexts. Essential characteristics are discovered, leading to a comprehensive understanding of these technologies.

II. Current Status of ATSC 3.0 MIMO

Having the basic SISO-form ATSC 3.0 deployed in the real world, broadcasters have subsequently started preparing to bring ATSC 3.0 MIMO to the earth.

The broadcasters in South Korea are envisaging two possibilities for ATSC 3.0 MIMO: (*i*) A way more enriched ultra-high-definition (UHD) video service with 8K resolution [6], [7]; and (*ii*) an integral of multiple 4K UHD programs in the same frequency channel, where each program is from the different service provider. Principally, South Korea pursues high-quality and enriched videos more than other features. The latter imagination (*ii*) is conceived as appealing to the practitioners because it can create new business opportunities and stimulate the network operator's role.

III. Emerging Technologies Based on ATSC 3.0 MIMO

A. Reuse-1 MIMO

Reuse-1 MIMO is a topology allowing the coexistence of plural, different, uncoordinated MIMO service signals in the same single radio frequency. Shortly speaking, multiple different service providers here share the same frequency channel [8], [9]. The powerful error protection capability of ATSC 3.0 enables this system, allowing the receiver to decode the desired signal successfully from a noisy mixture of plural MIMO service signals.

Brazilian broadcasting enablers are especially interested in this topology, particularly concerned with Brazil's spectrum circumstance. The new Brazilian broadcasting standard project, so-called *TV 3.0*, announced the mandate of reuse-1 operability on a MIMO basis.

This measure was to create additional data capacity while coping with an oversaturated spectrum issue. Brazil's radio spectrum dedicated to terrestrial broadcasting is devastatingly saturated since there are so many on-air programs ongoing simultaneously. To resolve this problem, Brazil is attempting

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to build a totally new, MIMO-based network foundation that would be not backward compatible.

The receiver at an arbitrary spot can tune to the desired service signal by pivoting the receive antenna properly, aligning it to the desired source's direction, cutting off the undesired signals by leaving them somewhere off the beam. Combined with the robust channel coding of ATSC 3.0, this assessment facilitates reuse-1 MIMO network even though many service providers are sharing the frequency, making the signal space *crowded*.

1) Single frequency network (SFN) with MIMO broadcasting

MIMO SFN could be considered a counterpart of reuse-1 MIMO, while single-frequency channel transmissions underlie both technologies. MIMO SFN lets clusters of towers transmit the same MIMO signal with centralized coordination, whereas the reuse-1 MIMO gives a mixture of different MIMO service signals.

B. B-Comp MIMO

The concept B-Comp MIMO has emerged from the countries that have already commenced ATSC 3.0 SISO services. This is considered a lubricating technology that assists a soft transition from SISO to MIMO ecosystem, or a spectrally efficient platform to embrace diverse target device-ends in the same frequency channel [10]-[13].

Specifically, B-Comp MIMO is a co-transmission of SISO and MIMO signals [10]. To this end, the physical layer multiplexing between them can rely on time division multiplexing (TDM) or layered division multiplexing (LDM). For example, B-Comp MIMO can harness the benefits of MIMO technology, serving dedicated MIMO terminals equipped with dual-polarized antennas, while serving SISO-based (physically constrained) mobile terminals and legacy television sets simultaneously in the same physical layer frame. As is designed, both types of end-terminals operate without any conflict.

C. CB MIMO

In terms of capacity amplification, CB MIMO goes one step further than the original ATSC 3.0 MIMO. CB MIMO utilizes two, consecutive or non-consecutive frequency channels along with leveraging cross-polarized MIMO technology at the same time [14]. This is, in essence, an integration of channel bonding and MIMO both defined in ATSC 3.0 physical layer.

By employing parallel transmission paths, ATSC 3.0-based CB MIMO is expected to provide up to about 200 Mbps data capacity.

IV. Conclusion

This paper introduced several variants of ATSC 3.0 MIMO to summarize the evolution of MIMO broadcasting technology. Reuse-1 MIMO, B-Comp MIMO, and CB MIMO were investigated, whose target markets deviate in different directions. For each technology, we exhibited the backgrounds and features. The implications and potential advancements of these technologies were discussed, emphasizing their role in achieving higher data rates and improved flexibility.

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