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Efficient, low-cost techniques to verify carrier aggregation in mobile devices

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ABSTRACT

Carrier aggregation (CA) is a key feature of recent wireless standards (4G, 5G, NR, etc.) that enables combining of two or more carriers into a single data channel to increase capacity. The number of carrier combinations can be very large, and verifying all combinations, or even a representative fraction thereof, involves a time-consuming and expensive commitment of engineering resources and test equipment. Per the techniques described herein, for time-division duplex standards, a first mobile device under test (DUT) is verified for CA operation by a second DUT. For example, a transmit CA combination of a first DUT is verified by the proper detection of the CA combination by a second DUT. The techniques simplify CA testing and reduce verification/compliance costs.

KEYWORDS

- Carrier aggregation
- Test and verification
- LTE
- 5G
- EUTRA-NR Dual connectivity (ENDC)
- Time-division duplex (TDD)
- New radio (NR)

BACKGROUND

Carrier aggregation (CA) is a key feature of recent wireless standards (4G, 5G, NR, etc.) that enables combining of two or more carriers into a single data channel to increase capacity. The number of carrier combinations can be very large, and verifying all combinations, or even a representative fraction thereof, involves a time-consuming and expensive commitment of engineering resources and test equipment.

DESCRIPTION

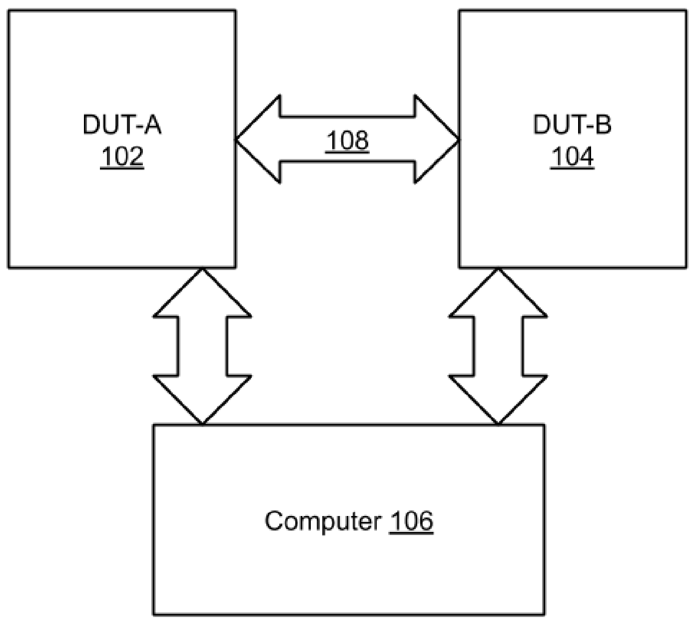

Fig. 1: Test setup to verify carrier aggregation

Fig. 1 illustrates a test setup to verify carrier aggregation, per techniques of this disclosure. The techniques apply to wireless standards that use time-division duplex (TDD), where the uplink and downlink signals are duplexed in time. In TDD systems, the uplink and downlink signals are situated at the same frequency and occupy the same bandwidth such that two mobile devices can be configured to effectively serve as test equipment for each other.

A first mobile DUT (102) is coupled to a second DUT (104) via a radio-frequency network (108), e.g., RF cables, power splitters, power combiners, etc. as necessary. For example, two RF splitter/combiners can be used to connect all necessary RF ports together so an RF signal can travel from any port of a DUT to any port of the other DUT. At any time, both DUTs operate on identical frequencies and occupy the same bandwidth. Serving as a receiver or detector, DUT-B verifies the CA combination transmitted by DUT-A. Serving as transmitter, DUT-A verifies that DUT-B can receive (detect) the transmitted CA combination. In this manner, both the transmit and the receive modes of carrier aggregation are verified. The transmit-receive roles of the DUTs are reversed and the tests repeated. Both DUTs are controlled by a computer (106) that sequences through the CA combinations and logs test results. A regular personal computer with equipment-control software can control both DUTs to operate on the band of CA combination that is under verification.

The test setup disclosed herein is inexpensive, quickly configurable, and costs only a fraction of conventional test methodologies that involve expensive test equipment and highly trained personnel. The test procedure itself finishes in a fraction of the time needed for conventional methodologies.

CONCLUSION

Per the techniques described herein, for time-division duplex standards, a first mobile device under test (DUT) is verified for CA operation by a second DUT. For example, a transmit CA combination of a first DUT is verified by the proper detection of the CA combination by a second DUT. The techniques simplify CA testing and reduce verification/compliance costs.