Adaptive Relay Transceiver

Sponsoring MTT-S Technical Committee

MTT-20 (Wireless Communications)

Coordinator(s)

Xun Luo, xun-luo@ieee.org
Zhizhang David Chen, z.chen@dal.ca

Competition Summary

Low power wireless communication has been proven to be a critical part of Internet of Things (IoT) and coming 5G wireless communications. A relay system is highly valuable to overcome obstacles that block radio wave propagation. This competition is aimed to design such a system. Design entries will be scored based on data-rate, power adaptivity, and power consumption of the relay transceiver under 4% error vector magnitude (EVM) of the received signal at the receiver.

Detailed Competition Description and Rules

The objective of the project is to design a low-power high-speed relay transceiver with power adaptivity. The relay transceiver should receive the signal from the signal generator (considered as the transmitter) and then transmit the signal to the spectrum analyzer (considered as the receiver). Such a relay transceiver should have the following strict conditions:

- Operating frequency: any frequency between 5.0 and 5.5 GHz, but the relay transceiver is suggested to operate in different frequency relay mode
- Modulation: at least 64 QAM
- Date with data-rate: at least 250 Mbps
- Output power of the signal generator: +10 dBm
- Output power of the relay transceiver: +20 dBm at maximum
- The longest dimension of the antenna used: 3 cm at maximum (connector not included)
- Antennas used in the relay transceiver: 2 at maximum, vertical monopole. If two antennas are used, the distance between these antennas should be no more than 15 cm
- Antenna of the transmitter: vertical monopole (connected to the signal generator)
- Antenna of the receiver: vertical monopole (connected to the spectrum analyzer)
- No array is allowed for each antenna used
- Use of off-shelf commercial components or devices: allowed
- Power supply: No internal battery is allowed. But one DC power supply with four channels (0-20

V, 0-3 A) is provided by the organizers

If a design entry or submission of the above relay transceiver does not meet any of the above conditions, the submission will be disqualified, and the tests will not be conducted.

The test setup is shown in Figure 1. The following parameters will be tested and measured during the competition.

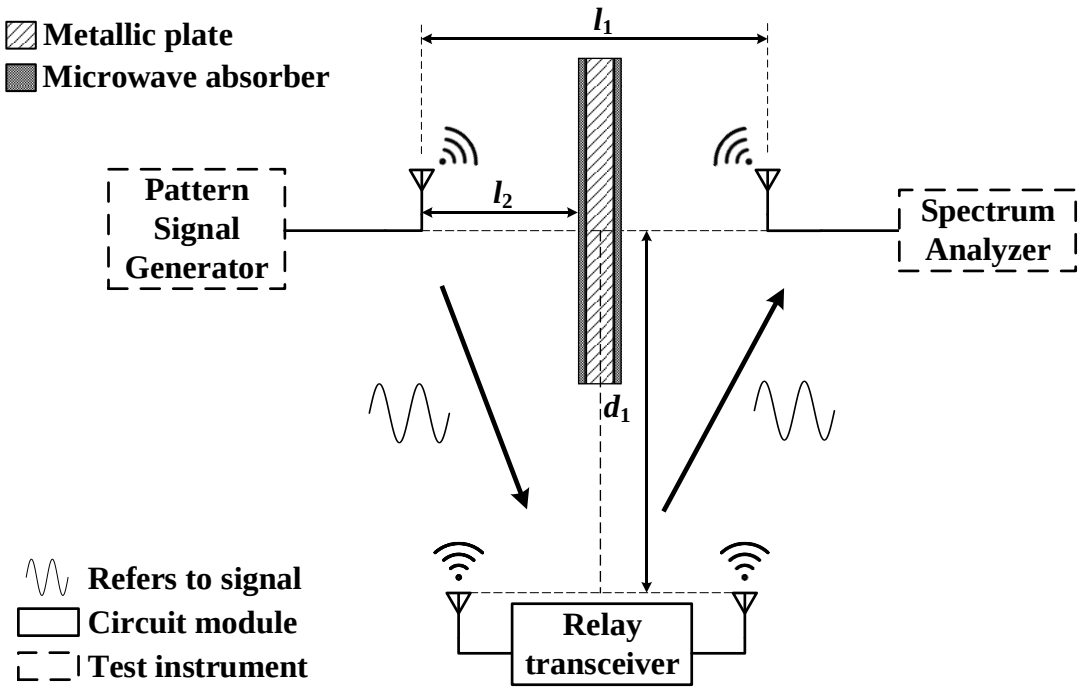

Figure 1. The test setup.

The obstacle is a metallic plate with microwave absorber covering its surface where the size is 0.5 m (width) 0.5 m (height) × 0.01 m (thickness). The output port of the relay transceiver must be a female SMA connector. A signal generator (considered as a transmitter), a spectrum analyzer (considered as a receiver), a metered power supply (0-20 V, 0-3 A), and a 6½ digital multi-meter will be available on-site for the measurement. The relay transceiver is to be placed in between the signal generator (transmitter) and the spectrum analyzer (receiver) to exam its performances. The relay transceiver is to be designed and brought to the student design competition site by the student participating teams for measurement. The signal generator and the spectrum analyzer will be provided by the organizers on site for the measurement.

During the competition, the following measurements will be conducted to score each design entry.

1) R_b: This parameter measures the data rate of the relay transceiver. The system is first set up with the following conditions: l_1 = 2.0 m, l_2 = 1.0 m, d_1 = 1 m. Then, the transmission data-rate of the signal generator is increased from 250 Mbps gradually until the EVM reaches 4%; the data rate at 4% EVM is recorded as R_b in Gbps.
2) P_1 and P_2: These two parameters evaluate the power adaptivity of the relay transceiver. The system is first set up with the following conditions: l_1 = 2.0 m, l_2 = 1.0 m, d_1 = 0.5 m. Under the fixed distance d_1, a date-rate no less than 250 Mbps and EVM better than 4%, the DC power consumption by the relay is measured and recorded as P_1 in mW. Once P_1 is measured, the distance d_1 will be raised to 5 m, and with a date-rate no less than 250 Mbps and EVM better than 4%, the power consumption of the relay is recorded as P_2 in mW.

Note:

1. The locations of the antennas connected to the signal generator, the relay transceiver designed, and the spectrum analyzer are defined as locations of the transmitter, relay transceiver and the receiver, respectively. If two antennas are used in the relay transceiver, the antenna near the metallic plate will be considered as the location of the relay.
2. To keep the competition length within a reasonable amount of time, students will have maximum 10 minutes to tune their system before the test or measurements. Once the measurements start for each design, no mechanical tuning is allowed.
3. An example for different frequency relay mode: signal generator (considered as a transmitter) operates at 5-5.15 GHz, spectrum analyzer (considered as a receiver) operates at 5.35-5.5 GHz.

Evaluation Criteria

Once each design is measured, the following formulas are used to determine its score:

$$S_1 = 2 \times \frac{(R_b - 0.25)}{(R_{b,\max} - 0.25)},$$

where $R_{b,max}$ is the maximum value of R_b among all the participating teams. Both $R_{b,max}$ and R_b are in the unit of Gbps.

$$S_2 = \frac{P_{1,\min}}{P_1} + \frac{P_{2,\min}}{P_2},$$

where $P_{1,\min}$ and $P_{2,\min}$ is the minimum value of P_1 and P_2 among all the participating teams.

$$S_{total} = S_1 + S_2$$

Team with highest score will win the prize!

The participating teams will be asked to give a 10-minutes oral presentation to the students and judges before the test starts.

How to Participate

- Follow the instructions on the IMS2019 Student Design Competitions website to submit your student design competition application.
- Please also send a copy of the form to the organizers of this competition using their contact information listed at the beginning of this document.

Awards

The total prize money budgeted is $2000 per contest. The prize division is: the first place will receive $1200, the second place will receive $500, and the third place will receive $300. The judges reserve the right to change this allocation based on the number and quality of the entries, possible tied scores and other unforeseen scoring situations.