away from the digital TV broadcasting station. A charge pump circuit was optimized to rectify and create 1.8–3.3 V from ambient RF power (below 25 dBm) at the UHF band.

In green cognitive radio(CR)systems, RF harvesting is an energy form of particular potential because the green CR can transmit data on the idle spectrum while harvesting energy from the busy spectrum [30] Another advantage of RF energy is the simultaneous transfer of wireless information and power [31]

In CR, RF energy harvesting implementation can be modelled in two ways:

1) Separated energy harvester and information receiver. In this a dedicated, separated energy harvester is present because of which simultaneous energy harvesting and consumption (sensing, transmission) is possible.Two separate receiving antennas are required for data detection and energy harvesting respectively.
2) Co-located energy harvester and information receiver. This requires only one set of antenna for both energy and data reception. It can be implemented using two architectures: power splitting and time splitting. In power splitting part of the received power is utilized for energy harvesting purposes and the other for simultaneous data detection. In time splitting, the complete received RF signal is utilized alternately for data detection (energy consumption) for a fixed time duration and for energy harvesting for another fixed time duration.

The unified model of the RF energy harvesting process of these architectures is given in Eq. (1) [30]

$$E_h = \alpha\eta|h|^2E \qquad (1)$$

where h is channel condition between the RF energy harvester and the RF energy source

$|h|^2E$ represents the energy of the received RF signals.

$0 < \alpha \leq 1$ is the time switching ratio or power splitting ratio that is used for energy harvesting.

Existing literature assumes that energy harvested in current time slot can only be utilized in the subsequent time slots because of the half duplex constraint [33]. Because of this before performing any cognitive functions the CR to checks the residual energy levels in the above architectures.

Additional cognitive functionality in the form of harvesting strategies are requered, for instance, in the time switching architectures to specify whether to harvest and how long to harvest. For example if the battery used for energy storage in the energy harvester is charged to its capacity, the CR will benefit by not assigning any more time slots to energy harvesting.

Also it seems that no single power source is sufficient for the energy requirements of a CR. For energy harvesters to be a viable alternative, a combination of sources need to be harvested in the same device depending on its applications.

2. Conclusion

Harvesting energy from ambient energy sources is not only advantageous in terms of sustainable development but also in terms of less maintenance requirements (changing batteries etc) and zero recurring costs. Various ambient energy sources are described and its seen that the output power of all of them as a small sized(physically) energy harvester is very less. So either we need to work on increasing their efficiencies or on devising methods for hybrid energy harvesters which can utilize multiple energy sources to generate required higher levels of power. In CR systems RF energy harvesting can not only be performed using unintended signals(signals not containing data for the CR) for example GSM, WiFi(if applicable) which are omnipresent in urban environments but also on intended signals (signals containing data for CR). Two models are outlined for RF energy harvesting in CR.

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