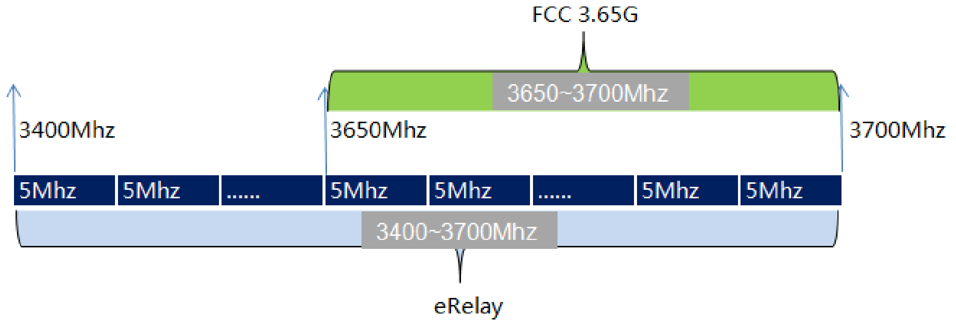
1. **Address the key requirements for operation using restricted contention base protocol opportunities for other transmitters to operate. Please note that this requires recognizing like systems that permit operation on a co-channel.**

ERelay is the backhaul system includes the BS and the RRN3301. And the BS is constituted by BBU + RRU (RRU3332 or RRU 3232). ERelay BS is the center point of the P2MP backhaul. It integrates radio control and management, RRN3301 access management and provide transmission interface to the existing backhaul. eRelay support TDD 2.6GHz (2575~2615MHz) and TDD 3.5GHz (3400~3700MHz). The recent FCC publication of “Memorandum Opinion and Order” on June 7, 2007 released 50 MHz spectrum for broadband wireless access applications. The most eminent difference in FCC ruling for this band is that it is “licensed”, while allowing both “unrestricted contention-based protocols” and “restricted contention-based protocols.”



In many cases, eRelay may be deployed with other wireless system at the same site or close to each other. With the fact that inter-system interference is inevitable due to transmitter spurious emission and receiver blocking characteristics especially when they are close to each other in terms of frequency, it is very important to analyze these interferences to help the filter design, co-site engineering and full spectrum usage.

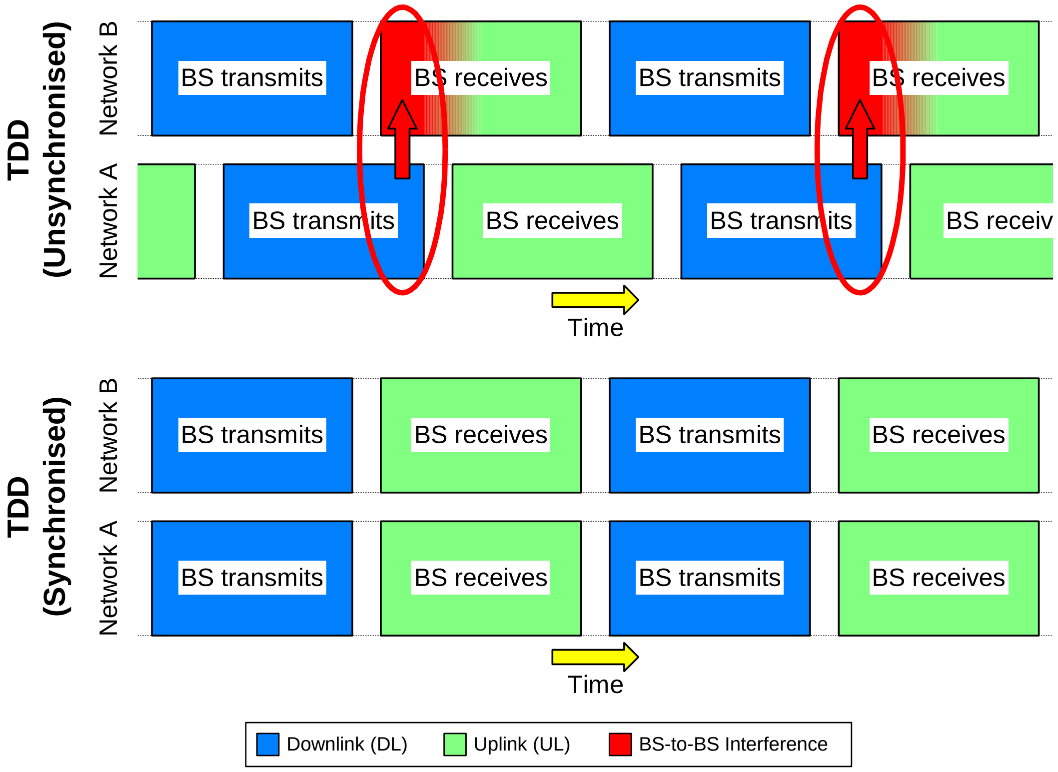


Figure 1-1 TDD Interference cause

eRelay BS is a TDD system which requires time synchronization, such synchronization could use either GPS or IEEE 1588v2. The BS uses a GPS system or 1588V2 server to synchronize the 5ms framing and uses the same TDD ratio to allow similar systems to operate in the same TDD ratio without interfering one BS receive with other BS transmit. Since transmit and receive of all similar BSs are done in the same synchronized periods without any overlapping between transmit and receive periods of each and other it provides satisfactory sharing of spectrum with similar systems.

eRelay BS is usually co-sited with macro base stations, operator may choose Independent antenna and feeders for these two system depend on specific requirements. The benefits are that the antenna azimuth and down tilt may be tuned independently. Since eRelay performance is highly dependent on the RRN3301 channel quality, fine tune of the antennas is very important. RNP (Radio network planning) engineers should also pay special considerations to the antenna separations between eRelay BS and other BS for inter-system interference.

The eRelay downlink transmission scheme is based on OFDM. Due to the relatively long OFDM symbol time in combination with a cyclic prefix, OFDM provides a high degree of robustness against channel frequency selectivity.

RRN3301s' transmission is allocated by the BS in which a contention between the RRN3301s is prevented. In addition to prevent a weak RRN3301 of one sector to be interfered by other sector's strong RRN3301 and ATPC (Automatic Transmit Power Control) mechanism is executed by the RRN3301s, to allow satisfactory sharing of the spectrum with similar systems in a co-channels. eRelay system uses ATPC that calculates the link loss and limits the RRN3301 transmission power to prevent contention with neighbor sectors RRN3301s.

2. Provide any additional manuals and operational descriptions to allow the reviewer to understand the protocol and is operation.

2.1 Restricted Protocol Description

The following synchronized TDD framing diagram is used to allow satisfactory sharing of the spectrum with similar systems.

As refer in <3GPP TS 36.211>, frame structure type 2 is applicable to TDD. Each radio frame of length $T_\mathrm{f} = 307200 \cdot T_\mathrm{s} = 10\,\mathrm{ms}$ consists of two half-frames of length $153600 \cdot T_\mathrm{s} = 5\,\mathrm{ms}$ each. Each half-frame consists of five subframes of length $30720 \cdot T_\mathrm{s} = 1\,\mathrm{ms}$. The supported uplink-downlink configurations are listed in Table 2-1 where, for each subframe in a radio frame, "D" denotes the subframe is reserved for downlink transmissions, "U" denotes the subframe is reserved for uplink transmissions and "S" denotes a special subframe with the three fields DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is given by Table 2-1 subject to the total length of DwPTS, GP and UpPTS being equal to $30720 \cdot T_\mathrm{s} = 1\,\mathrm{ms}$. Each subframe i is defined as two slots, $2i$ and $2i+1$ of length $T_\mathrm{slot} = 15360 \cdot T_\mathrm{s} = 0.5\,\mathrm{ms}$ in each subframe.

Uplink-downlink configurations with both 5 ms and 10 ms downlink-to-uplink switch-point periodicity are supported.

In case of 5 ms downlink-to-uplink switch-point periodicity, the special subframe exists in both half-frames.

In case of 10 ms downlink-to-uplink switch-point periodicity, the special subframe exists in the first half-frame only.

Subframes 0 and 5 and DwPTS are always reserved for downlink transmission. UpPTS and the subframe immediately following the special subframe are always reserved for uplink transmission.

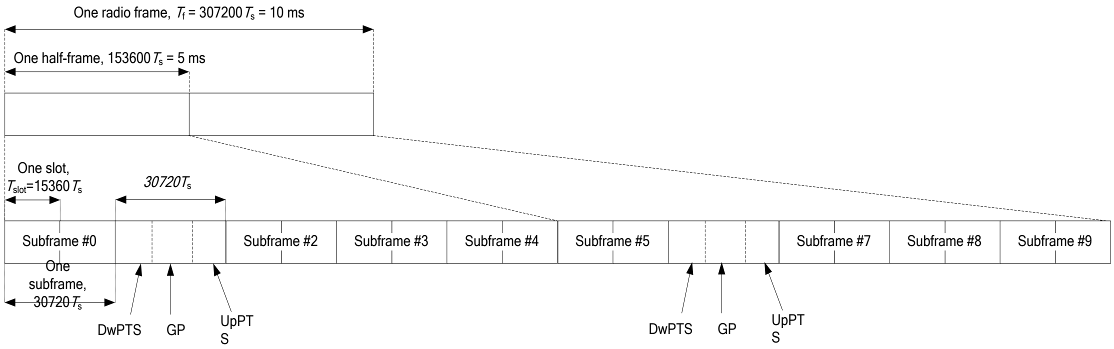


Figure 2-1 Frame structure type 2 (for 5 ms switch-point periodicity).

<table>
<tr><th rowspan="3">Special subframe configuration</th><th colspan="3">Normal cyclic prefix in downlink</th><th colspan="3">Extended cyclic prefix in downlink</th></tr>
<tr><th rowspan="2">DwPTS</th><th colspan="2">UpPTS</th><th rowspan="2">DwPTS</th><th colspan="2">UpPTS</th></tr>
<tr><th>Normal cyclic prefix in uplink</th><th>Extended cyclic prefix in uplink</th><th>Normal cyclic prefix in uplink</th><th>Extended cyclic prefix in uplink</th></tr>
<tr><td>0</td><td>$6592 \cdot T_s$</td><td rowspan="5">$2192 \cdot T_s$</td><td rowspan="5">$2560 \cdot T_s$</td><td>$7680 \cdot T_s$</td><td rowspan="4">$2192 \cdot T_s$</td><td rowspan="4">$2560 \cdot T_s$</td></tr>
<tr><td>1</td><td>$19760 \cdot T_s$</td><td>$20480 \cdot T_s$</td></tr>
<tr><td>2</td><td>$21952 \cdot T_s$</td><td>$23040 \cdot T_s$</td></tr>
<tr><td>3</td><td>$24144 \cdot T_s$</td><td>$25600 \cdot T_s$</td></tr>
<tr><td>4</td><td>$26336 \cdot T_s$</td><td>$7680 \cdot T_s$</td><td rowspan="3">$4384 \cdot T_s$</td><td rowspan="3">$5120 \cdot T_s$</td></tr>
<tr><td>5</td><td>$6592 \cdot T_s$</td><td rowspan="4">$4384 \cdot T_s$</td><td rowspan="4">$5120 \cdot T_s$</td><td>$20480 \cdot T_s$</td></tr>
<tr><td>6</td><td>$19760 \cdot T_s$</td><td>$23040 \cdot T_s$</td></tr>
<tr><td>7</td><td>$21952 \cdot T_s$</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>8</td><td>$24144 \cdot T_s$</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Table 2-1 Configuration of special subframe (lengths of DwPTS/GP/UpPTS)

The TDD system Uplink-downlink configuration is as follows:

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

Table 2-2 Uplink-downlink configurations

ERelay is TDD system and the supporting special subframe configuration is including 5 and 7. And the supporting Uplink-downlink configuration is including 0, 1 and 2. ERelay support the configuration in blue in above tables.

OFDM has been adopted as the downlink transmission scheme for the 3GPP Long-Term Evolution (LTE). As TDD LTE system, eRelay downlink transmission scheme is also based on OFDM. Transmission by means of OFDM can be seen as a kind of multi-carrier transmission. The ‘physical resource’ in case of OFDM transmission is often illustrated as a time-frequency grid according to Figure 2-2 where each ‘column’ corresponds to one OFDM symbol and each ‘row’ corresponds to one OFDM subcarrier.

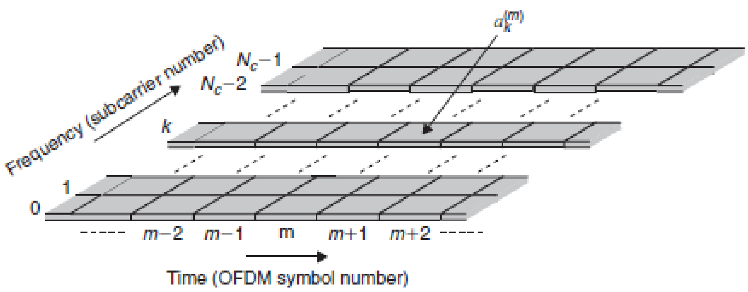


Figure 2-2 OFDM time-frequency grids

In contrast to the kind of multi-carrier transmission, any corruption of the frequency-domain structure of the OFDM subcarriers, e.g. due to a frequency selective radio channel, may lead to a loss of inter-subcarrier orthogonality and thus to interference between subcarriers. To handle this and to make an OFDM signal truly robust to radio-channel frequency selectivity, cyclic-prefix insertion is typically used.

To deal with this problem and to make an OFDM signal truly insensitive to time dispersion on the radio channel, so-called cyclic-prefix insertion is typically used in case of OFDM transmission. As illustrated in Figure 2-3, cyclic-prefix insertion implies that the last part of the OFDM symbol is copied and inserted at the beginning of the OFDM symbol. Cyclic-prefix insertion thus increases the length of the OFDM symbol from Tu to Tu +Tcp, where Tcp is the length of the cyclic prefix, with a corresponding reduction in the OFDM symbol rate as a consequence.

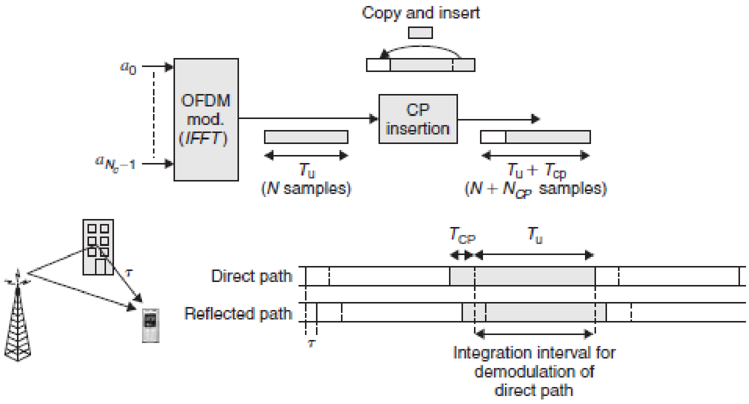


Figure 2-3 Cyclic-prefix insertion

Cyclic-prefix insertion is beneficial in the sense that it makes an OFDM signal insensitive to time dispersion as long as the span of the time dispersion does not exceed the length of the cyclic prefix. In general, there is a trade-off between the power loss due to the cyclic prefix and the signal corruption (inter-symbol and inter-subcarrier interference) due to residual time dispersion not covered by the cyclic prefix and, at a certain point, further reduction of the signal corruption due to further increase of the cyclic-prefix length will not justify the corresponding additional power loss. This also means that, although the amount of time dispersion typically increases with the cell size, beyond a certain cell size there is often no reason to increase the cyclic prefix further as the corresponding power loss due to a further increase of the cyclic prefix would have a larger negative impact, compared to the signal corruption due to the residual time dispersion not covered by the cyclic prefix

Due to the relatively long OFDM symbol time in combination with a cyclic prefix, OFDM provides a high degree of robustness against channel frequency selectivity.

Although signal corruption due to a frequency-selective channel can, in principle, be handled by equalization at the receiver side, the complexity of the equalization starts to become unattractively high for implementation in a mobile terminal at bandwidths above 5 MHz. Therefore, OFDM with its inherent robustness to frequency-selective fading is attractive for the downlink, especially when combined with spatial multiplexing.

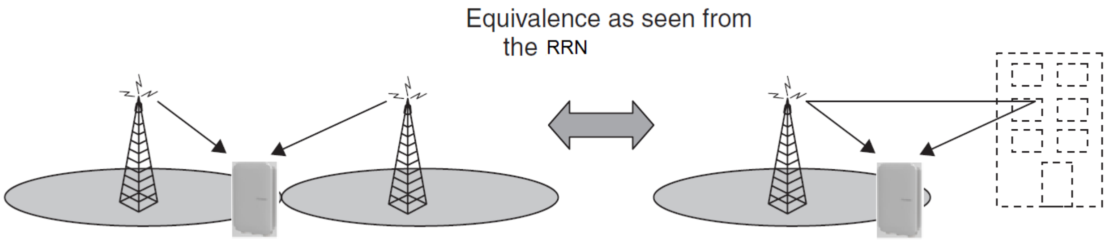


Figure 2-4 Equivalence between simulcast transmission and multi-path propagation

One way to improve the provisioning of broadcast/multicast services in a network is to ensure that the broadcast transmissions from different cells are truly identical and transmitted mutually time aligned. In this case, the transmissions received from multiple cells will, as seen from the RRN3301, appear as a single transmission subject to severe multi-path propagation as illustrated in Figure 2-4.

In case of such identical time-aligned transmissions from multiple cells, the 'intercell interference' due to transmissions in neighboring cells will, from a terminal point of view, be replaced by signal corruption due to time dispersion. If the broadcast transmission is based on OFDM with a cyclic prefix that covers the main part of this 'time dispersion', the achievable broadcast data rates are thus only limited by noise, implying that, especially in smaller cells, very high broadcast data rates can be achieved. The OFDM receiver does not need to explicitly identify the cells to be soft combined. Rather, all transmissions that fall within the cyclic prefix will 'automatically' be captured by the receiver.

2.2 Describe the method to permit occupancy.

The occupancy of traffic requirement brought up by RRN3301 (client device) and the time slots are arranged by BS (the master).

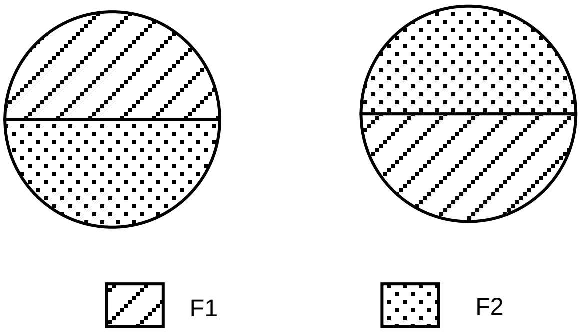
2.3 Describe the action taken if two or more transmitters simultaneously access the same channel by the master and the client devices.

RRN3301 is LTE client device, two or more transmitters simultaneously access the channel will occur at the access stage. LTE PHY level random access procedure is used to solve the conflict. When there are conflicts between client devices. The client devices will make a random back-off for another access.

The following general rules could be used for two or more transmitters simultaneously access the same channel. However it should be noted that the isolation requirements really depend on the RF characteristic of different equipments. Precise evaluation should be performed for each specific scenario.

a) We share the same channel using the radio planning. We have 25MHz that we can plan to distribute 2 channels of 10MHz each that allows distribution of the frequencies between the neighbors BS.

The following shown scenario is also satisfied using 2 channels of 10MHz each.



The permutations are orthogonal in which reduces the interferences.

b) Regarding TDD system with neighboring spectrum, it is highly recommended to synchronize DL: UL transmitting and receiving to avoid extra filter costs and get more spectrum usage. In addition the protocol allows permutation of OFDM subcarriers to prevent contentions and interference.

c) Synchronization prevents Transmit and Receive overlapping of the sites.

d) Guard band: more guard band means more channel offset between the systems, and will cause less out of band emission and less out of band reception.

e) Filter: media filters may have significantly better performance compared with metal filters; however media filters are usually more cost. Media filter would be required to meet the European CEPT requirements for co-site macro site. Narrow band filter would be required for RRN3301 and small cell co-site.

f) Space isolation: more space isolation between the systems means less aggressor signal would fall into the victim system. In practice antenna usually have much smaller vertical HPBW, this makes it easier to separate the antenna in the vertical direction. Location of eRelay BS and RRN3301 may be carefully selected to avoid the interference from the other systems of nearby bands.

   The Guard band, the Narrow band filter and Space isolation are efficient to mitigate the system interference. The above 3 methods are used together or separate according to different scenarios to mitigate the interference as small as possible before it falls into the victim system.

g) Both the RRN3301 and the BS uses directional antennas to reduce inter/intra site interference.

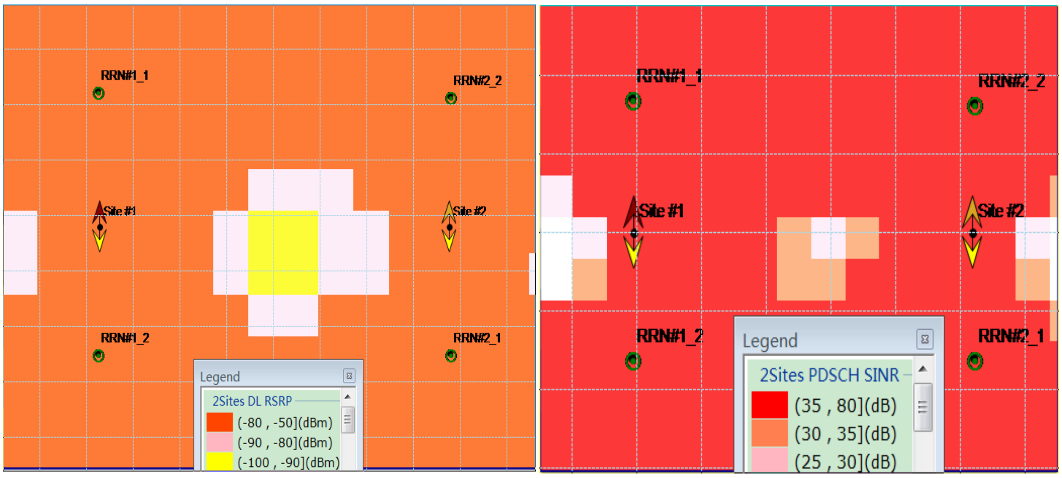
h) It is also good practice to tune the tilt of eRelay BS and RRN3301 to reduce inter/intra site interference.

i) ATPC (Automatic Transmit Power Control) mechanism is executed by the RRN3301s, to allow satisfactory sharing of the spectrum with similar systems in a co-channel.

j) We use different preamble index that identifies the BS in which RRN3301s can follow exactly the associated BS there are 4 combinations of preamble indexes.

All in all, considering all of above we do not see any problem to have coexistence of frequencies between the BSs.

The following interference suppression shown is the scenario of using 2 channels of 10MHz each.



2.4 Describe opportunities for other similar systems to operate - address how, or if, a different system operator using the same technology can operate in the same band.

The radio interference to other LTE devices connected to the BSs in the same system cased by RRN3301 is avoided by BSs side with TDD synchronization mechanism. The radio interference mitigation to the LTE devices connected to the BSs not in the same system (inter-system) cased by RRN3301 should be designed and deployed by the BSs in different systems.

Normally BS avoid inter-system interference by synchronization, ATPC, RNP (Radio network planning), space isolation etc. methods.