# IEEE 802
# Regulatory matters

## Liaison to ETS-BRAN

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**From:** Paul Nikolich, Chair, IEEE 802
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**Date:** January 25, 2002

**Subject:** DFS mechanisms

Dear Jamshid,

Thank you for your sharing the document JPT5G(02)18 with the IEEE 802 Radio Regulations group.

We have looked at the possibility of an improved method for radar detection and created a proposal that responds, from an IEEE 802 point of view, to the points raised in JPT5G (02)18. The details are included in the attached document (RR-02/018A).

We kindly invite ETSI-BRAN to review the material and give us feedback regarding its viaibility for the whole RLAN community.

Additionally, we request that ETSI-BRAN take this into consideration when responding to JPT5G.

With best regards,

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# IEEE 802 proposal relating to DFS and JPT5G proposal

# An 802 proposal resolves most of the issues with the JPT5G proposal for RLAN DFS

- JPT5G has proposed an algorithm and parameters for RLAN DFS
- Elements of the JPT5G proposal are unsuitable for operation with 802.11
- 802 proposes an improved method of determining the presence of a radar in a channel
- The 802 proposal has a variety of enhanced radar detection properties
- 802 needs to confirm and negotiate the provisional values for a variety of parameter values

# JPT5G RLAN DFS proposal

# JPT5G has proposed an algorithm and parameters for RLAN DFS

**JPT5G RLAN DFS proposal:**

- An RLAN shall not use a channel that:
  - It knows contains a radar
  - Has not been tested appropriately for the presence of a radar
- An RLAN shall test for the presence of a radar for at least:
  - 30 seconds after changing to a new channel, if the channel has not been used before or it the channel has not been tested for at least 30 seconds during the last 24 hours
  - 30 seconds if a channel was previously determined to contain radar
  - 20% of each 10ms period where testing occurs during period when the RLAN is quiet
- An RLAN shall assume it has detected a radar during a channel test if:
  - The average received power in any 0.1us period is greater than –61dBm and;
  - it cannot prove that the received power is not from a radar
- An AP shall notify all STAs in an RLAN that they should stop using a channel (and possibly the identity of the next channel) within 6ms of detecting a radar

# The values of the parameters in the JPT5G proposal are provisional

| Variable | Description of JPT5G proposal parameter | Provisional value |
|---|---|---|
| $T_{startup}$ | The minimum period for which a new channel must be tested if the channel has not been used before or if it previously contained a radar or if it has not been tested for at least $T_{startup}$ during the last $T_{maxage}$ | 30 seconds |
| $T_{average}$ | The maximum window over which the receive power must be averaged when measuring a channel for the presence of a radar | 100ns |
| $P_{threshold}$ | The maximum threshold for the average power, measured over $T_{average}$, that indicates the presence of a radar | -61dBm |
| $T_{maxage}$ | The minimum period after which the results of any old $T_{startup}$ tests for the presence of a radar in a channel are no longer valid. | 24 hours |
| $M_{test}$ | The minimum proportion of each $T_{cycle}$ cycle that must be reserved for testing while a channel is being used | 20% |
| $T_{cycle}$ | The maximum length of a cycle, of which a proportion must be reserved for testing while a channel is being used | 10ms |
| $T_{leave}$ | The maximum period in which the RLAN must notify STAs to leave a channel after detecting a radar in a channel | 6ms |

# JPT5G RLAN DFS proposal issues

# The JPT5G proposal could cause 802.11 RLANs to operate poorly, particularly in capacity constrained systems

- Under the JPT5G proposal, any short energy burst above –61dBm during the test period will cause an 802.11 RLAN to hop to a new channel
- The short energy burst could result from:
  - Random external noise
  - Packets or collisions from other RLANs in the same channel (multiple 802.11 RLANs can operate successfully in the same channel, unlike HIPERLAN 2)
- A channel hop will usually cause at least a short break in 802.11 RLAN operation and thus reduce network performance
- In an environment with many closely packed 802.11 RLANs (a capacity constrained system):
  - An RLAN may never find a “clear” channel because other RLANs or radars are operating in all channels
  - If an RLAN finds a “clear” channel because no “near” STAs in the other RLANs happen to transmit loudly enough while testing then it or another RLAN may have to hop again when the “near” STA transmits; system instability may result

# Two of the provisional parameters in the JPT5G proposal too low for operation with 802.11

| Variable | Evaluation of JPT5G proposal parameter | Provisional value |
|---|---|---|
| $T_{startup}$ | Probably reasonable | 30 seconds |
| $T_{average}$ | Probably reasonable | 100ns |
| $P_{threshold}$ | Probably reasonable | -61dBm |
| $T_{maxage}$ | Probably reasonable | 24 hours |
| $M_{test}$ | Probably reasonable | 20% |
| $T_{cycle}$ | Too short and presupposes that radars can only be detected during quiet periods. | 10ms |
| $T_{leave}$ | Too short for the communication necessary to coordinate channel change. | 6ms |

# 802 RLAN DFS proposal

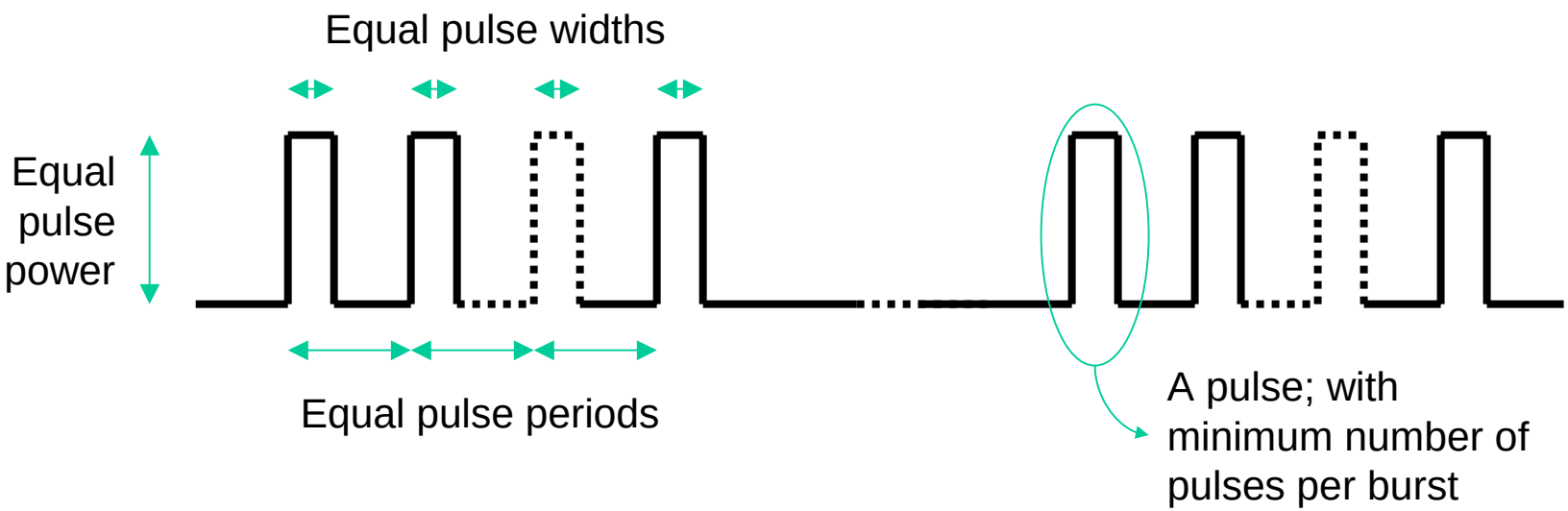
# 802 proposes an improved method of determining the presence of a radar in a channel

- An RLAN device determines that a radar is operating in a channel when in either a quiet period or a non-quiet period:
  - It receives at least [3, but >2] pulses of at least [–55 dBm]
  - It receives at least [5] pulses of at least [–61dBm]
- Pulses are defined to:
  - Start after a significant increase in power
  - Finish after a significant decrease in power
  - Have a width of [50ns-100us], corresponding to known radar types
  - Be periodic, within some tolerance, with a pulse period of no more than [1 second]
  - Have same power, within some tolerance
- More than one radar can be detected simultaneously by categorising each pulse by its periodicity, measured power and pulse width

# The key to the 802 proposal is a multi-pulse, high power characterisation of a radar signal

**Assumed radar characterisation:**

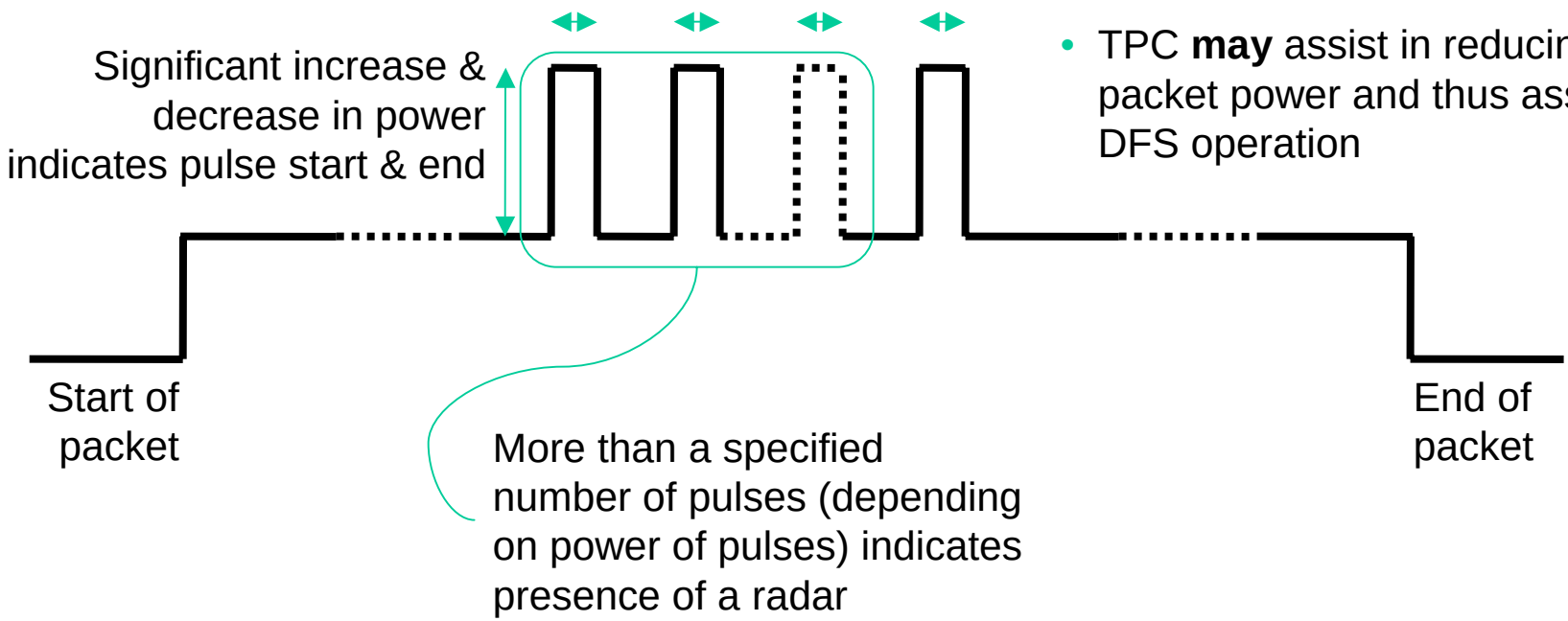
- High power pulses are more likely to indicate a radar and thus fewer pulses are required to confirm presence of a radar signal
- Low power pulses are less certain to indicate a radar and thus more pulses are required to confirm presence of a radar signal




802 proposal

# Properties of 802 RLAN DFS proposal

# The 802 proposal for radar characterisation allows radar detection to occur during normal packet reception, thus reducing detection time for radars received at higher powers




- Method relies on radar reception at a power significantly higher than packet reception
- TPC **may** assist in reducing packet power and thus assist DFS operation

# The 802 proposal avoids triggering a channel switch when random noise or packets and collisions from other RLANs are detected

# The radar detection time in the 802 proposal is a function of the radar properties and, for radars received at lower powers, the measuring properties of the RLAN

## Radar properties

- The detection time depends on the maximum time until an RLAN device receives either:
  - [5] consecutive pulses above the low threshold [-61dBm] at the receiver input
  - [3] consecutive pulses above the high threshold [-55dBm] at the receiver input
- The choice of the thresholds used depends on the:
  - Radar transmission power
  - Path loss from radar to RLAN
  - Position of RLAN in radar beam

## RLAN measuring properties

- Properties only affect detection of radars received at lower powers
- The maximum time between quiet measurement periods
- Period of quiet measurement periods
- Synchronisation between radar pulses and quiet measurement periods

**Note: most of these parameters also apply to the JPT5G proposal**

# Parameters of 802 RLAN DFS proposal

# 802 needs to confirm the provisional values for a variety of radar detection related parameter values

| 802 proposal parameters | Provisional value |
|---|---|
| Significant increase/decrease of power indicating the start/end of a pulse | [8 dB] |
| Low threshold for power of a pulse | [-61dBm] |
| Low threshold for minimum number of pulses in a low threshold pulse train | [5] |
| High threshold for power of a pulse | [-55dBm] |
| High threshold for minimum number of pulses in a high threshold pulse train | [3] |
| Pulse width | [100ns-100us] |
| Tolerance for pulse widths of two pulses to be considered equal | [TBD] |
| Pulse period | [2 - 1000 us] |
| Tolerance for pulse periods of two pulses to be considered equal | [25%] |

# 802 needs to confirm the provisional values for a variety of parameter values that were probably reasonable in the JPT5G proposal

| Variable | Description of JPT5G proposal parameter | Provisional value |
|---|---|---|
| $T_{startup}$ | The period for which a new channel must be tested if the channel has not been used before or if it previously contained a radar or if it has not been tested for at least $T_{startup}$ during the last $T_{maxage}$ | [30 seconds] |
| $T_{maxage}$ | The period after which the results of any old $T_{startup}$ tests for the presence of a radar in a channel are no longer valid. | [24 hours] |

# 802 proposes two new parameters related to the duration of interference

- $T_{detection}$ - The time to detect a radar from when it starts
  - JPT5G's proposal does not explicitly specify this parameter
  - Likely to be shorter than for the JPT5G proposal for radars received with higher powers; these radars do not require a quiet period for detection
  - If we specify this parameter (as a function of each radar type) then there is no need to specify frequency of quiet time and length of quiet time
- $T_{activity}$ - The total time during which RLAN devices may operate in the channel after detection of a radar
  - JPT5G specified 6ms
  - Option 1 on the following slide needs $T_{activity}$ to be [200ms] in 802 to allow the control traffic necessary to organise an orderly departure of the entire RLAN
  - Option 2, using the aggregate approach of on the following slide would require a total transmission time in the medium significantly less than [200 ms]

# 802 proposes two options related to the duration of RLAN activity after radar detection