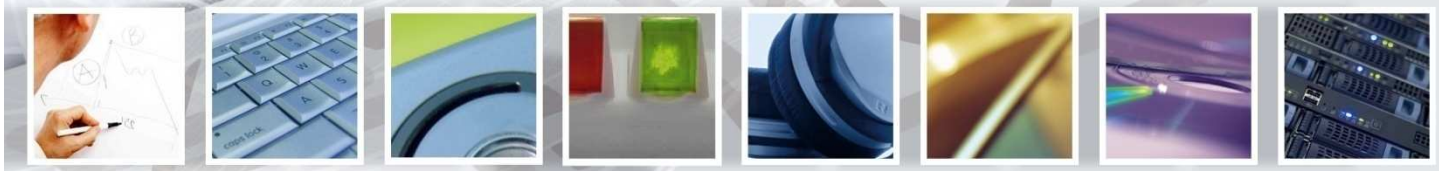
ETSI Test procedures for DAA certification

WALTER UWB Workshop

Sophia Antipolis, October 7, 2009



Content

- DAA Introduction
- ETSI Test procedures
  - Measurement Methods
  - Start-up Test for Radio Location and BWA
  - In-operation Tests for Radio Location and BWA
- Possible avoidance methods
- Conclusion

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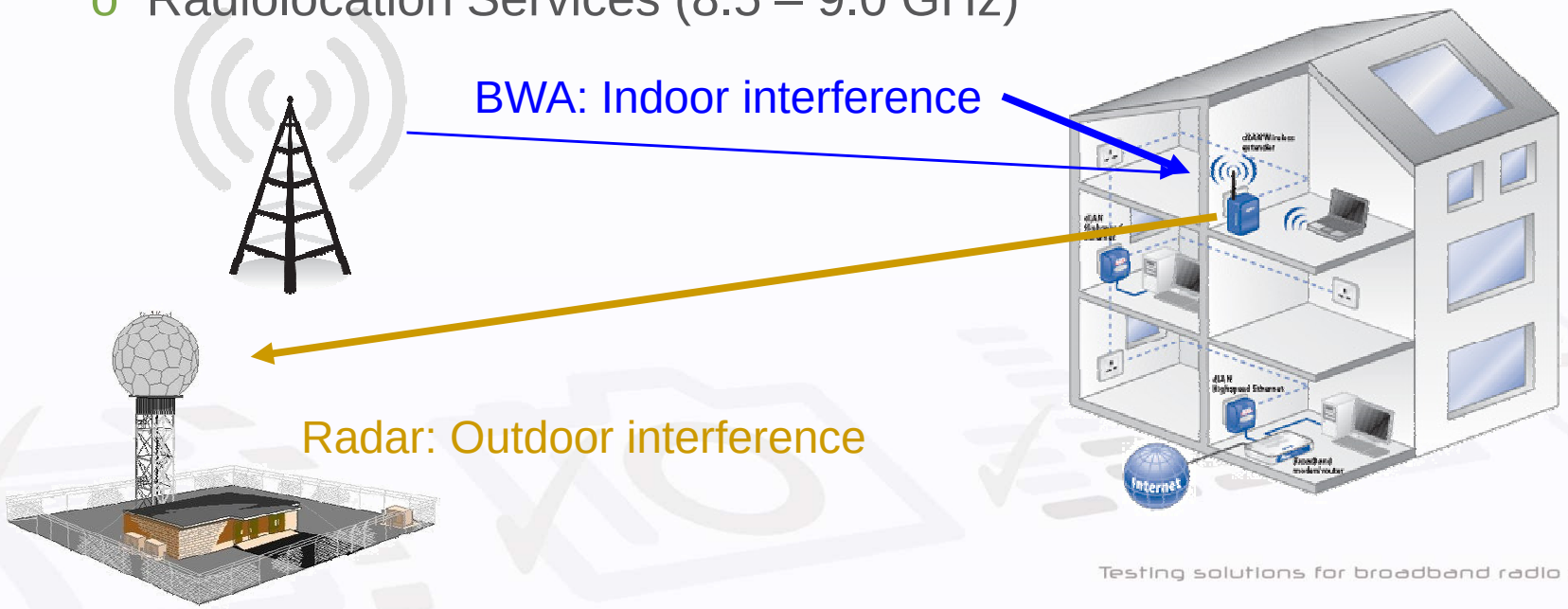
DAA Objective

- ✓ Protection of licensed services (victims) from interference from UWB systems operating in the 3.1 – 10.6 GHz range
- ✓ Victim types
  - o Radiolocation Services (3.1 – 3.4 GHz)
  - o BWA (3.4 – 4.2 GHz)
  - o Radiolocation Services (8.5 – 9.0 GHz)



ETSI Test Procedures for DAA

- ETSI EN 302 065 V1.2.1
  - Three victim scenarios
    - Radar 1 (3.1 – 3.4 GHz)
    - BWA (3.4 – 4.2 GHz)
    - Radar 2 (8.5 – 9.0 GHz)
  - Two UWB operating modes
    - Start-up
    - In-operation
  - Two measurement scenarios
    - Conducted
    - Radiated

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UWB Operating modes

- Start-up
  - The UWB device starts up from power-off state
  - Before starting operation into a non NI mode, a check for the presence of victim signals has to be performed

- In-operation
  - While operating the UWB device must constantly monitor its environment for the presence of victim signals

DAA Test Descriptions (TDs)

- 4 TDs for radar signals
  - 3 TDs for the start-up mode
  - 1 TDs for the in-operation mode
- 4 TDs for BWA signals
  - 3 TDs for the start-up mode
  - 1 TD for the in-operation mode
- Note: Mobile Wimax (802.16e-2005) has been selected as exemplary BWA technology
  - Bandwidth: 7 MHz
  - Three service types / modes have been defined
    - VoIP, Web surfing, Broadcast (includes Sleep Mode)

DAA Parameters – I –

- **Avoidance level:**
  - Maximum amplitude to which the UWB transmit power is set for the relevant protection zone
- **Detect and avoid time:**
  - Time duration between a change of the external RF environmental conditions and adaptation of the corresponding UWB operational parameters
  - ***Parameter:*** T_{avoid}
- **Detection probability:**
  - Probability that the DAA enabled UWB device reacts appropriately to a signal detection threshold crossing within the detect and avoid time
- **Maximum avoidance power level:**
  - UWB transmit power assuring the equivalent protection of the victim service
- **Minimum avoidance bandwidth:**
  - Portion of the victim service bandwidth requiring protection
- **Default avoidance bandwidth:**
  - Portion of the victim service bandwidth to be protected if no enhanced service bandwidth identification mechanisms are implemented in the DAA enabled devices

DAA Parameters – II –

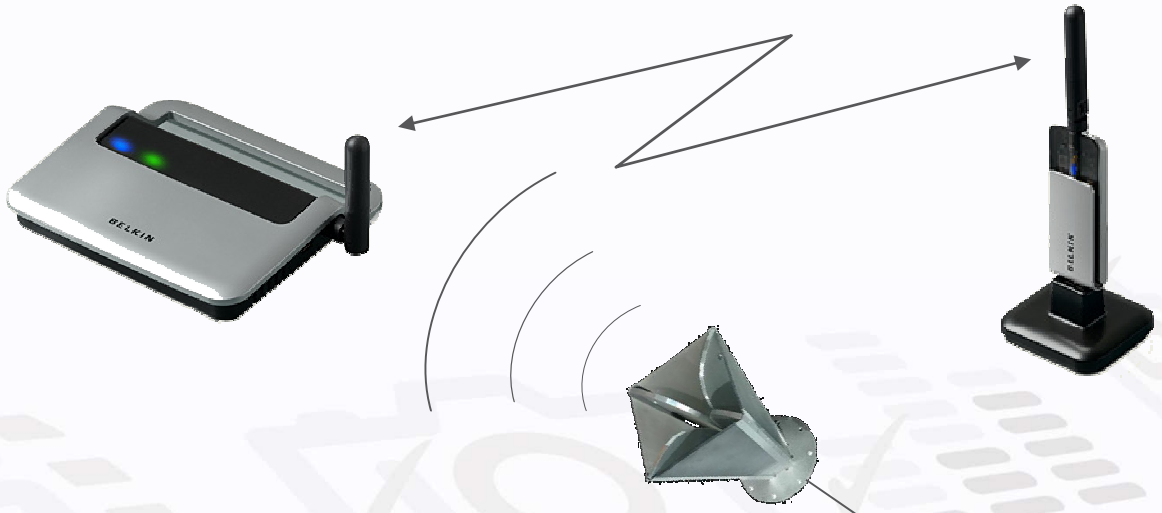
- **Minimum initial channel availability check time:**
  - Minimum time the UWB device spends searching for victim signals after power- on
  - ***Parameter:*** $T_{avail,\ Time}$
- **Non-Interference mode operation (NIM):**
  - Operational mode that allows the use of the radio spectrum on a non interference basis without active mitigation techniques
- **Signal detection threshold:**
  - Amplitude of the victim signal which defines the transition between adjacent protection zones
  - ***Parameter:*** D_{thresh}

DAA Test Setup Start-up

- ✓ Preferred setup: Radiated
- ✓ Single UWB device
- ✓ Test mode for startup test
  - o switch into a non NI mode after initial check time
  - o Indicator for victim detection could simplify the test procedure
  - o No need for peer device (test mode)

DAA Test Setup In Operation

- ✓ Preferred setup: Radiated
- ✓ UWB devices should be configured as slave pair or equivalent
- ✓ At least one of the devices must have DAA capability
- ✓ A good link between the two devices must be assured at all times.
- ✓ Only the DAA equipped device need be illuminated in the victim service field
- ✓ If this is not possible and where both devices are DAA enabled, care should be taken to prevent false triggering
- ✓ UWB Rx/Tx activity level 50%

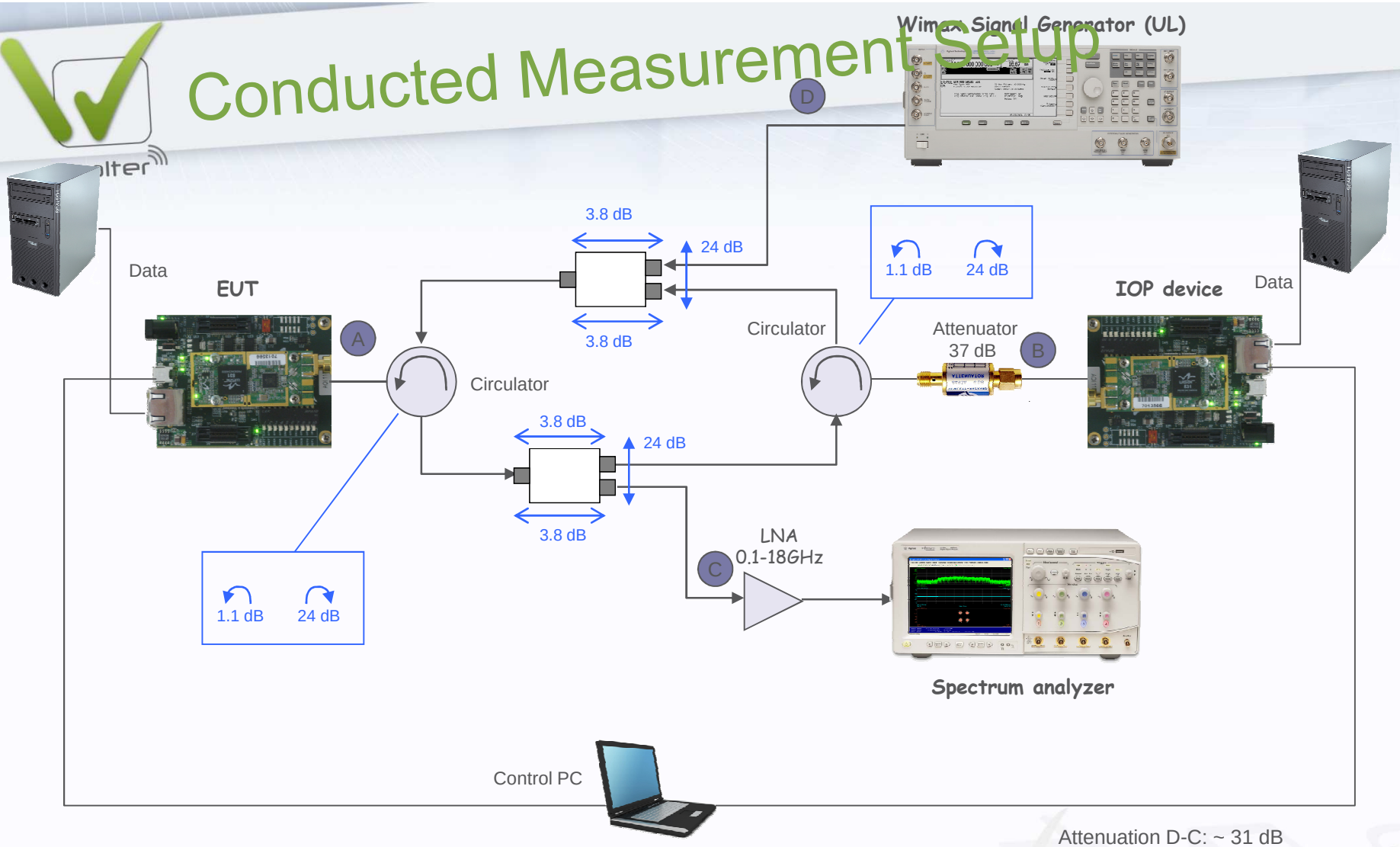


Measurement methods

- Conducted
  - Better signal quality
  - Only permitted measurement method in some countries
  - Potential impedance mismatch problems

- Radiated
  - Antennas of volume production equipment are frequently not detachable
  - Spectrum shaping / filtering function of antenna
  - Interference measurements in realistic environments with multiple disturbers, multiple victim services
  - Very low UWB signal levels make proper signal detection difficult

Conducted Measurement Setup



Attenuation D-C: ~ 31 dB

EUT
Attenuation A-C (forward path): ~ 5 dB
Attenuation A-C (reverse path): ~ 53 dB

Attenuation A-B (forward path): ~ 43 dB (=> 1m free-space distance)
Attenuation A-B (reverse path): ~ 89 dB

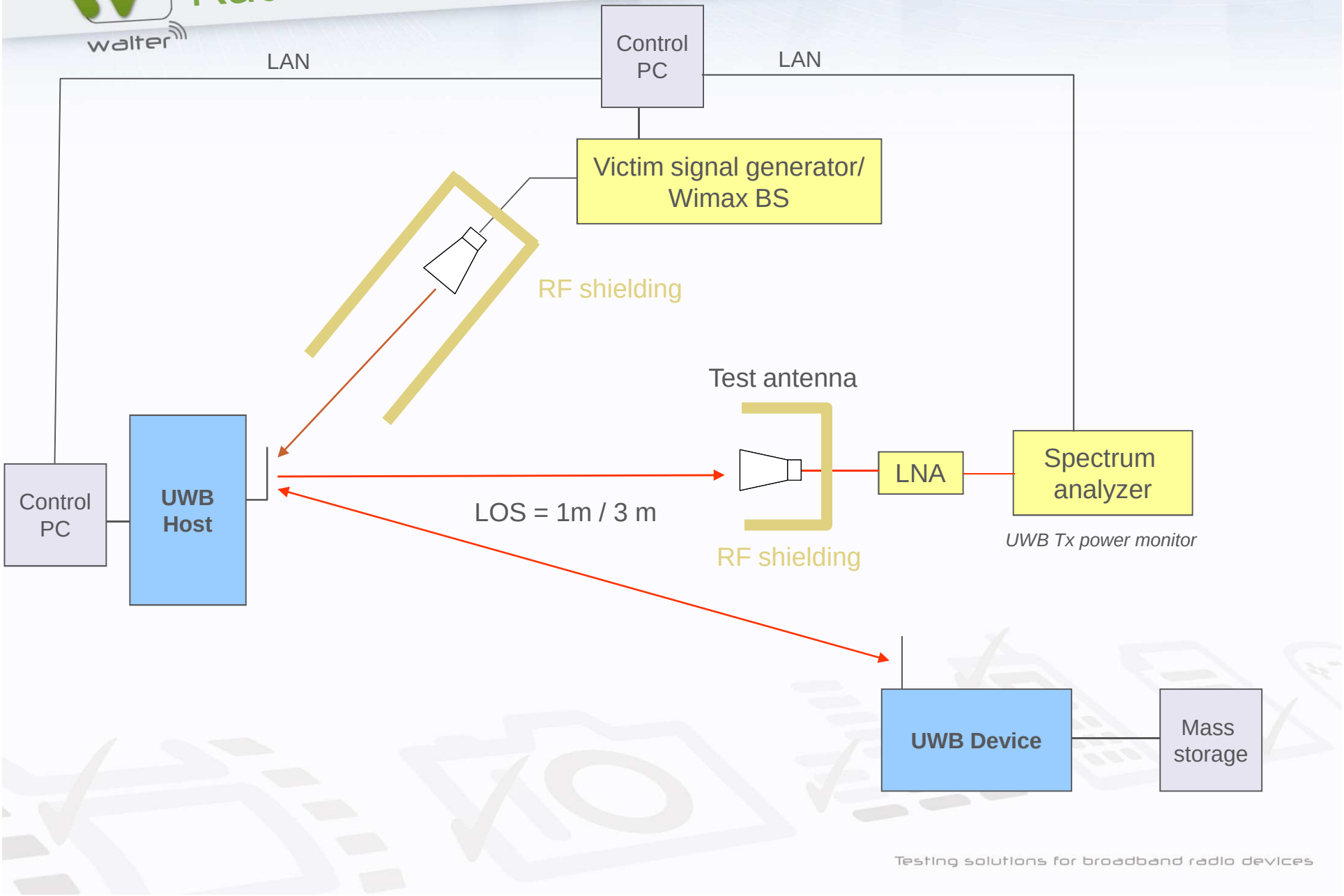
Note: Indicated attenuation values measured at 3.5 GHz

IOP device
Attenuation B-C (forward path): ~ 70 dB
Attenuation B-C (reverse path): ~ 85 dB

Attenuation B-A (forward path): ~ 43 dB (=> 1m free-space distance)
Attenuation B-A (reverse path): ~ 89 dB

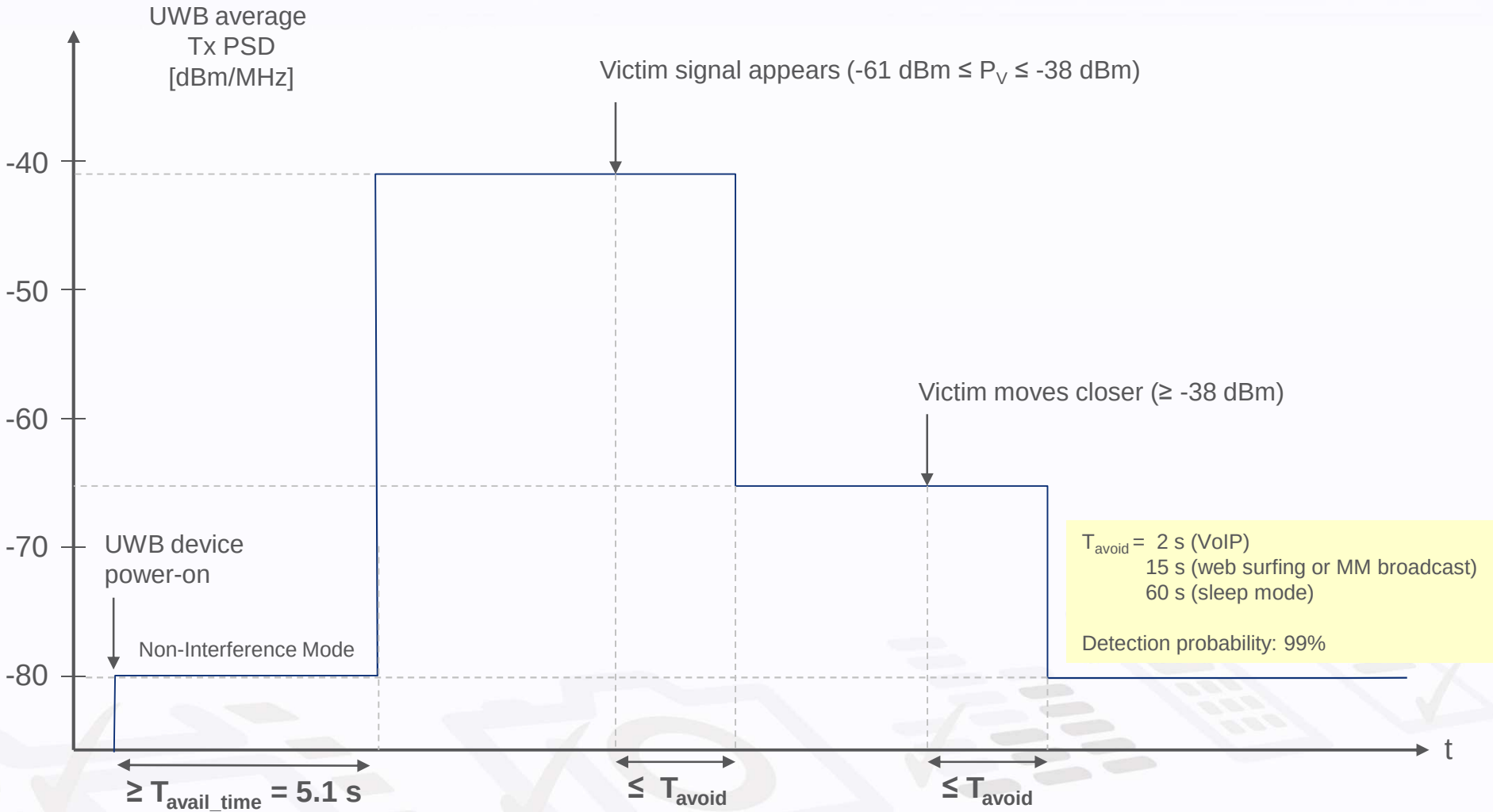
Attenuation range (measured between 3.0 and 5.0 GHz)
Power dividers/combiners: 3.8 – 4.2 dB (forward path), 23.5 – 25.1 dB (reverse path)
Circulators:0.9 – 1.3 dB (forward path), 22 – 37 dB (reverse path)

Radiated Measurement Setup proposal



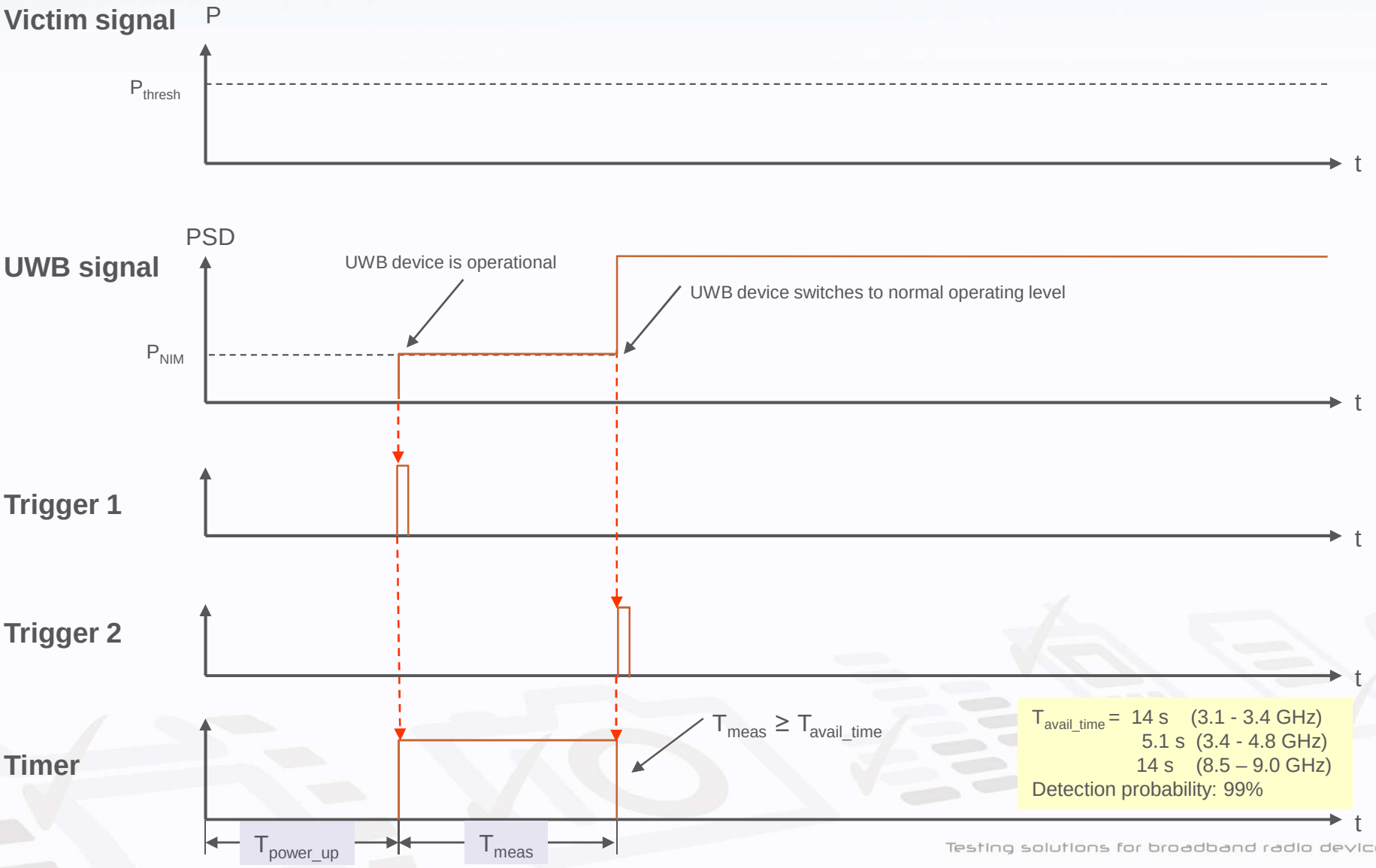
DAA operation – Example

- ✓ BWA (3.4 – 3.8 GHz)*



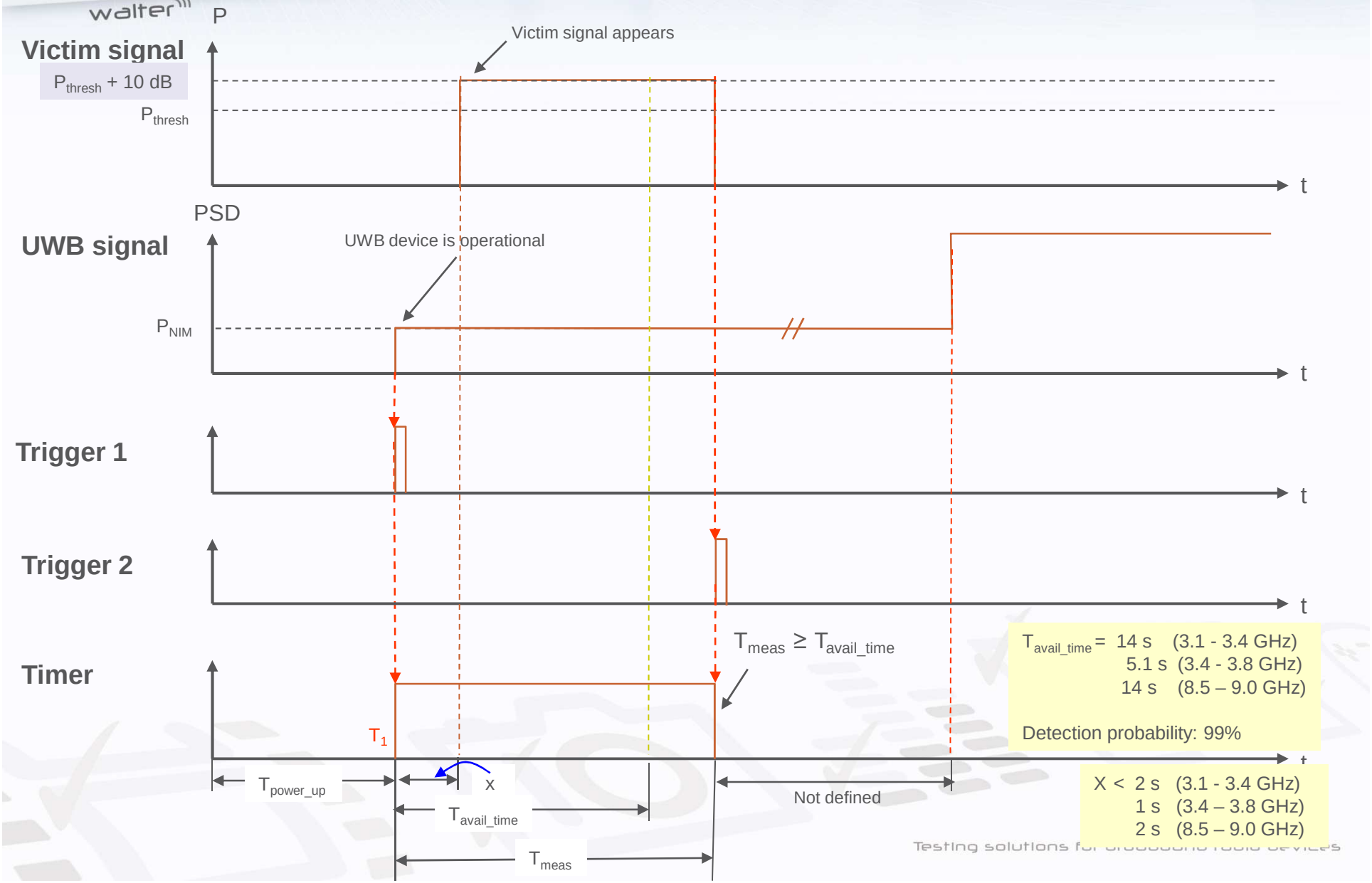
* For the 3.8-4.2 GHz band a NIM level of – 70 dBm/MHz has been defined

UWB "Start-up" mode (No victim signal present)



T_{avail_time} = 14 s (3.1 - 3.4 GHz)
5.1 s (3.4 - 4.8 GHz)
14 s (8.5 – 9.0 GHz)
Detection probability: 99%

UWB "Start-up" mode 1
(Victim signal appears at the beginning of availability check)

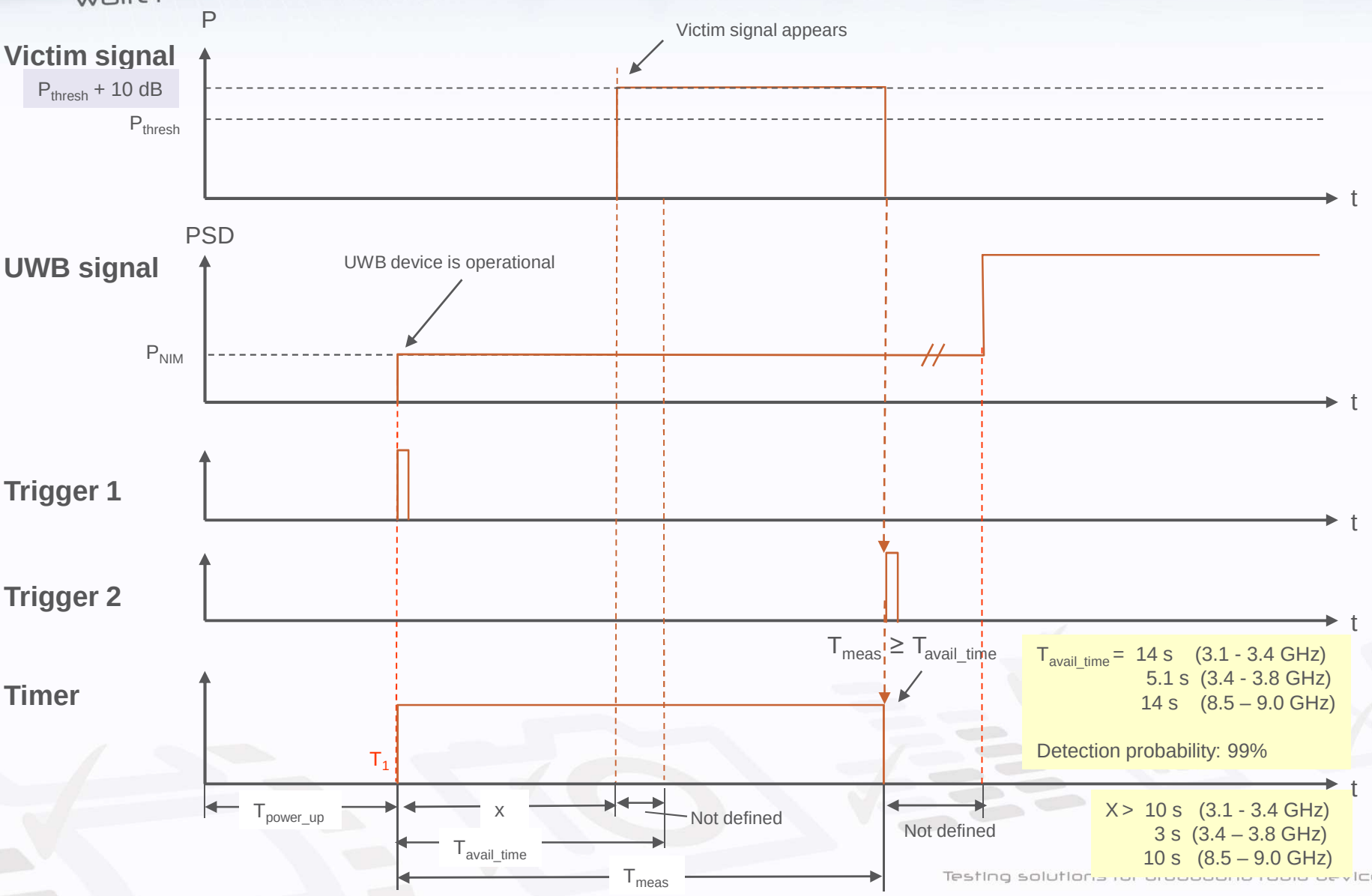


T_{avail_time} = 14 s (3.1 - 3.4 GHz)
5.1 s (3.4 - 3.8 GHz)
14 s (8.5 – 9.0 GHz)

Detection probability: 99%

X < 2 s (3.1 - 3.4 GHz)
1 s (3.4 – 3.8 GHz)
2 s (8.5 – 9.0 GHz)

UWB "Start-up" mode 2
(Victim signal appears at the end of availability check)

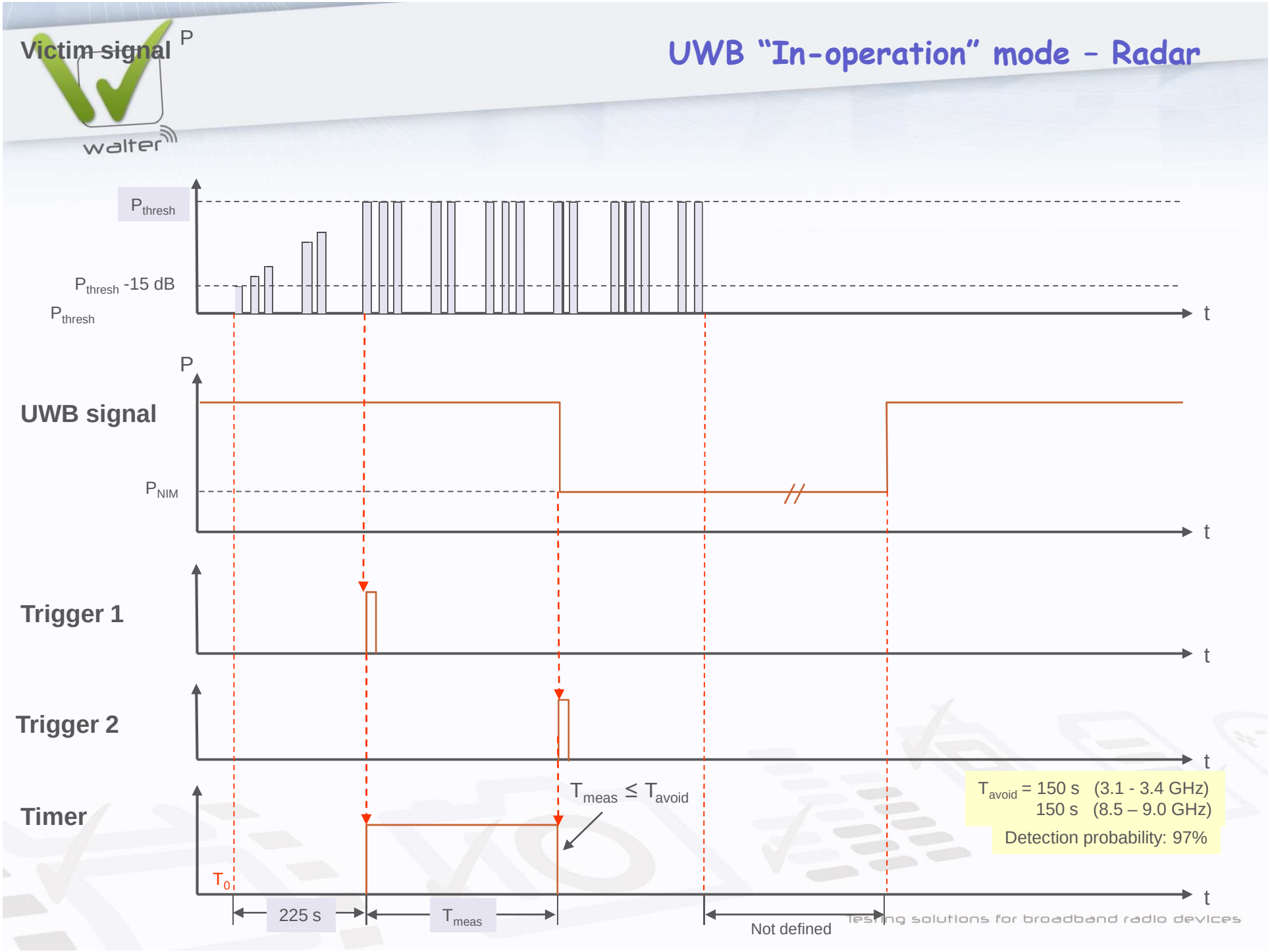


T_{avail_time} = 14 s (3.1 - 3.4 GHz)
5.1 s (3.4 - 3.8 GHz)
14 s (8.5 – 9.0 GHz)

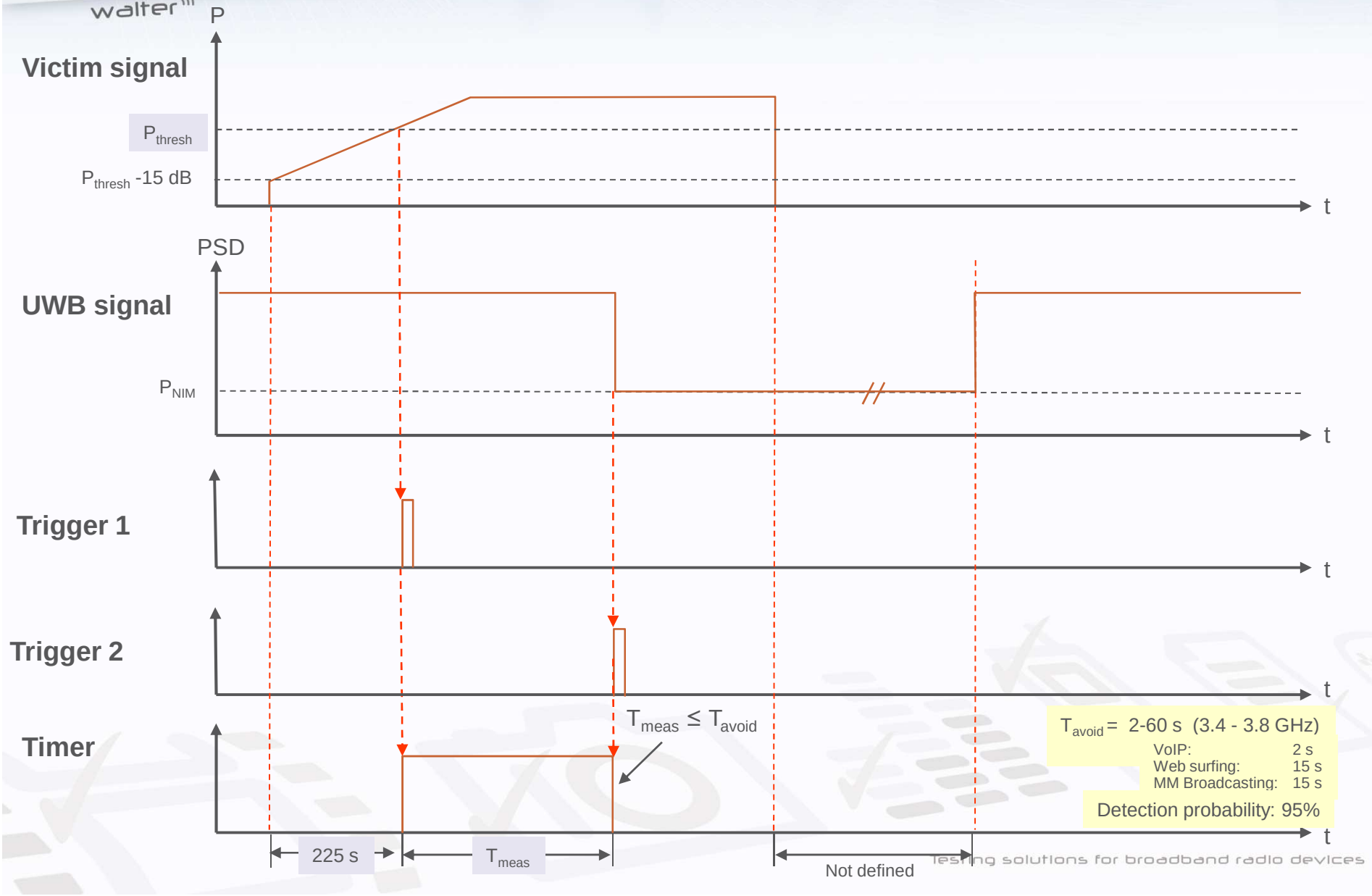
Detection probability: 99%

X > 10 s (3.1 - 3.4 GHz)
3 s (3.4 – 3.8 GHz)
10 s (8.5 – 9.0 GHz)

UWB "In-operation" mode – Radar



UWB "In-operation" mode – BWA

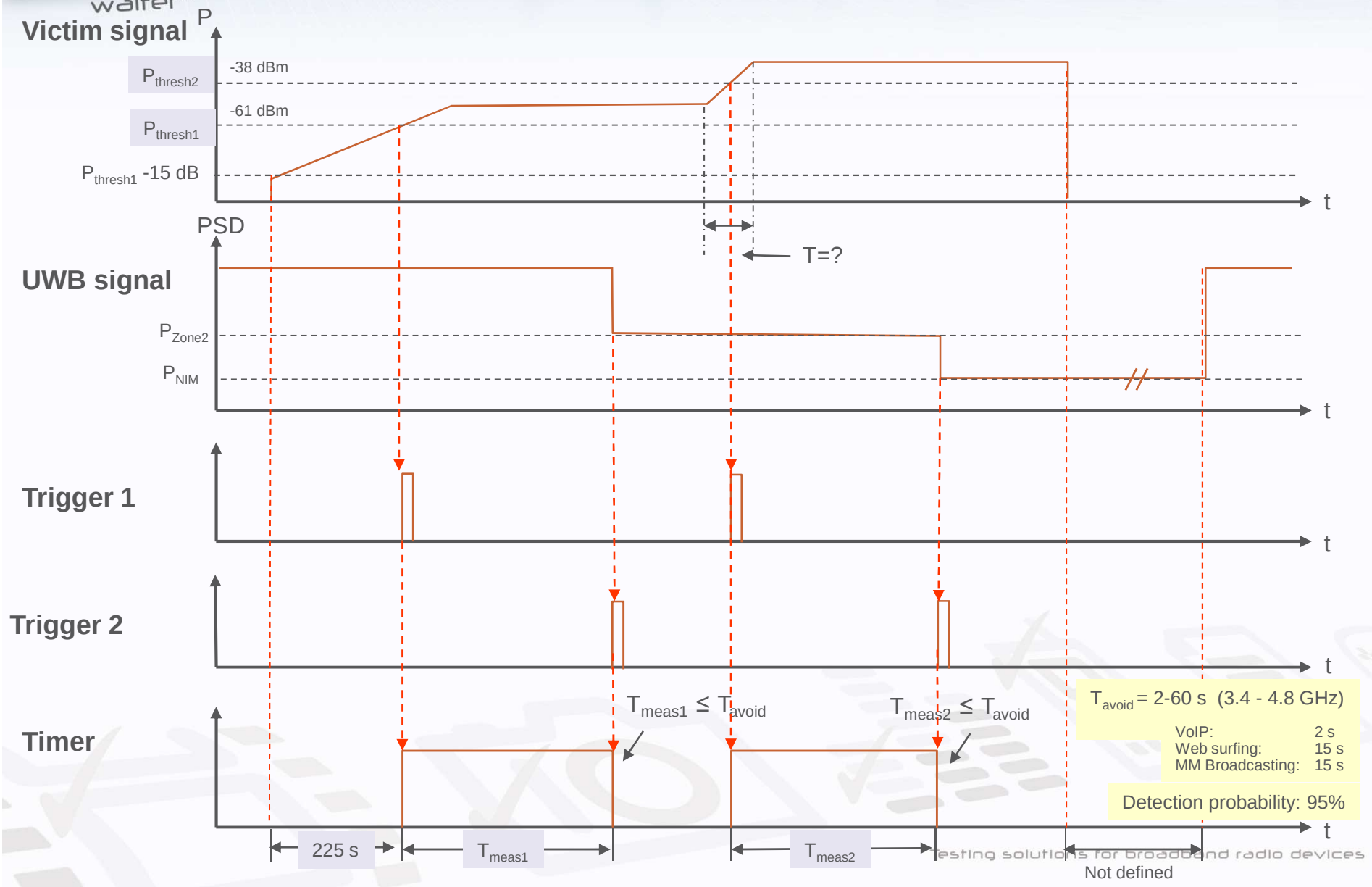


T_{avoid} = 2-60 s (3.4 - 3.8 GHz)

VoIP:	2 s
Web surfing:	15 s
MM Broadcasting:	15 s

Detection probability: 95%

UWB "In-operation" mode – BWA (2)



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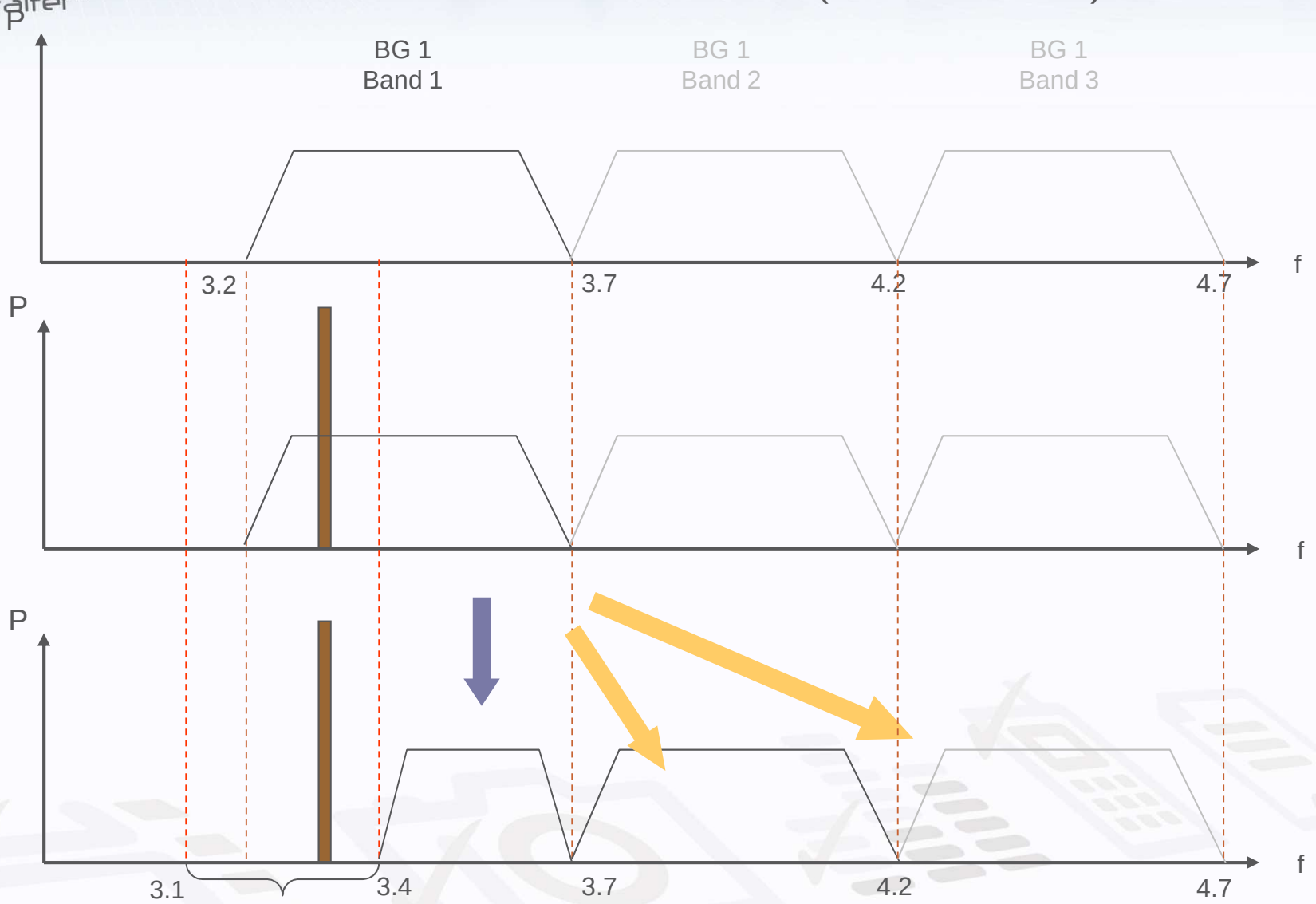
Avoidance Radio Location – I –

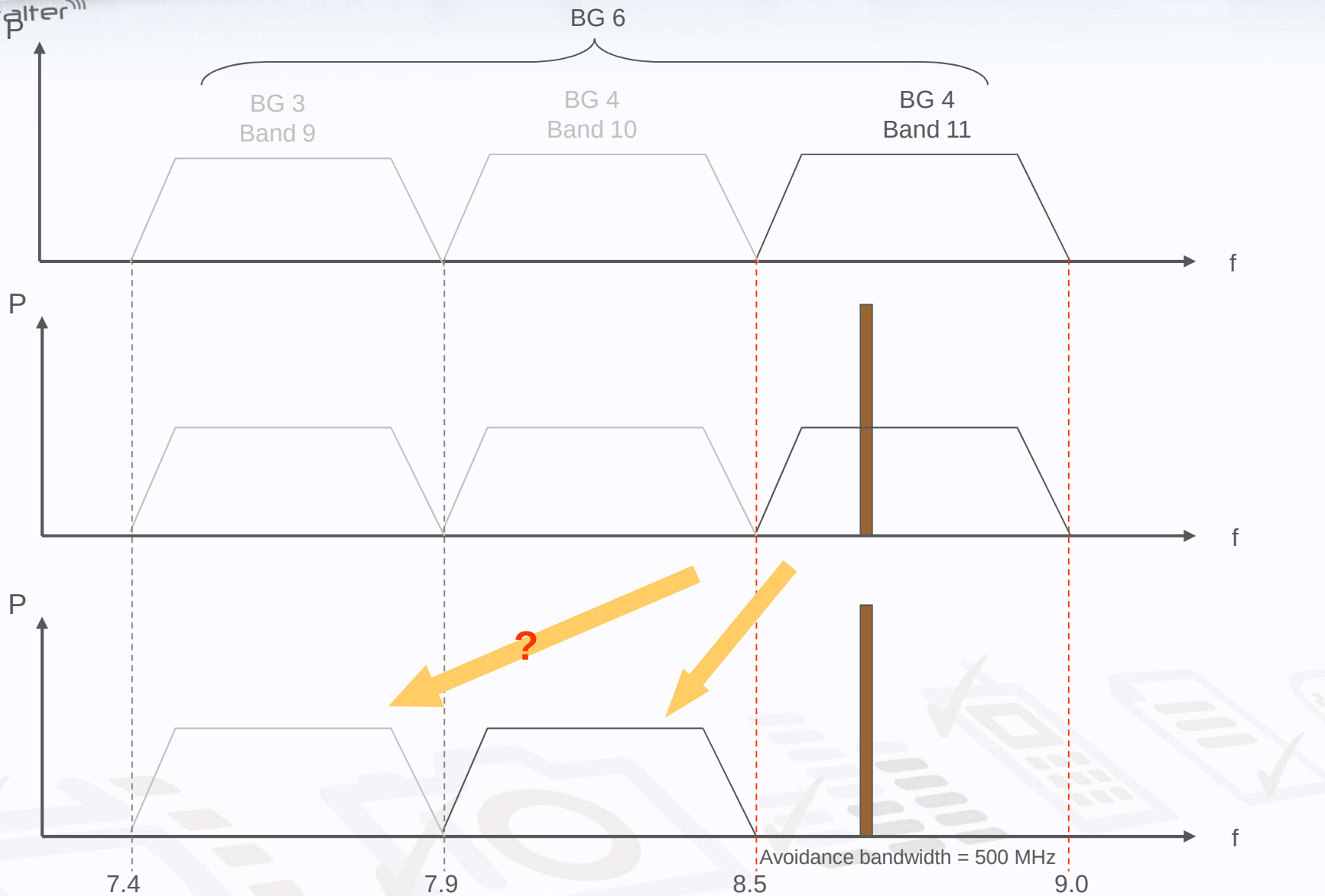
1. Radiolocation services (S/F-Band radar): 3.1 – 3.4 GHz



Avoidance bandwidth = 300 MHz

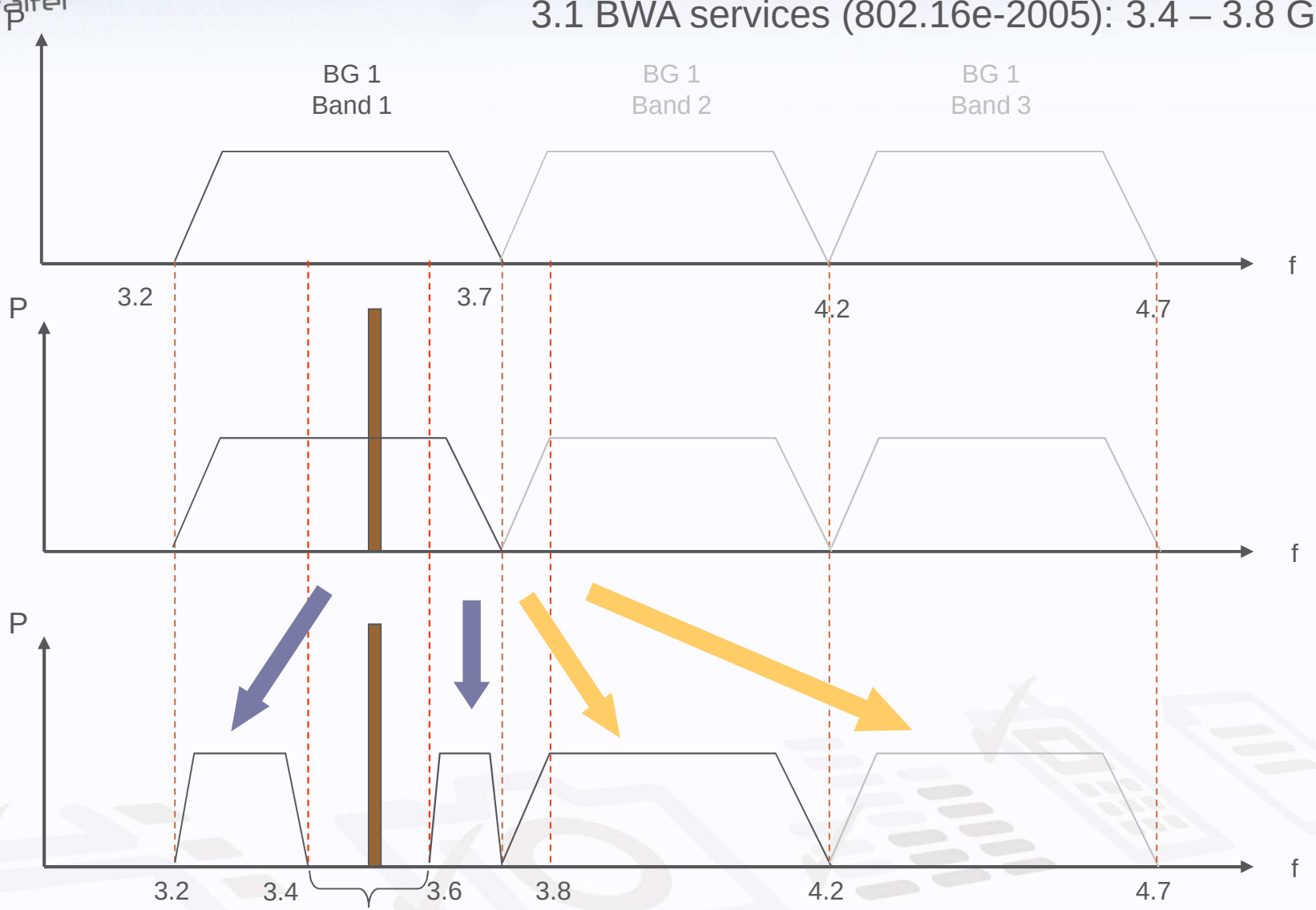
Avoidance Radio Location – II –

2. Radiolocation services (X/I-band radar): 8.5 – 9.0 GHz



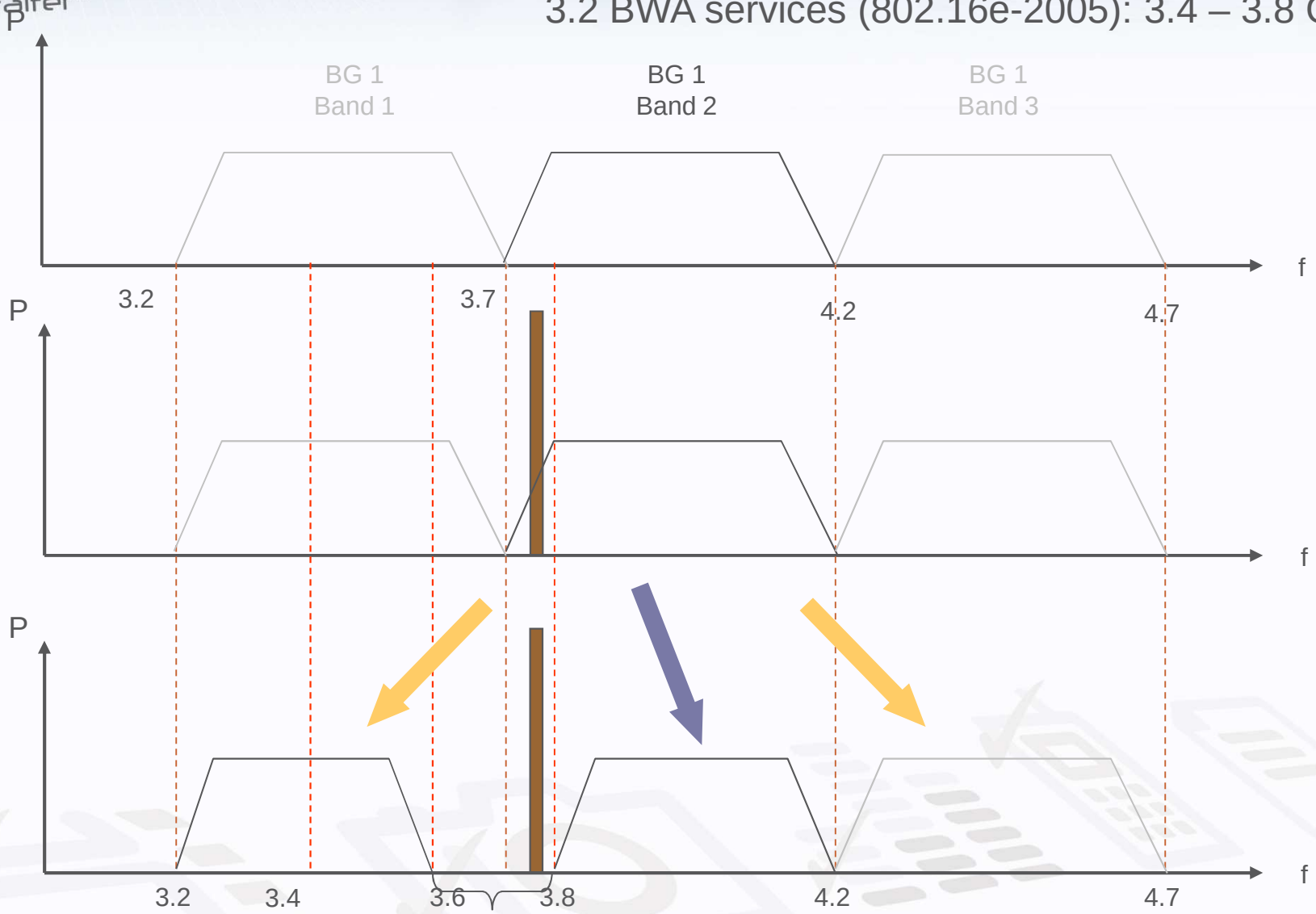
Avoidance BWA – I –

3.1 BWA services (802.16e-2005): 3.4 – 3.8 GHz



Avoidance BWA – II –

3.2 BWA services (802.16e-2005): 3.4 – 3.8 GHz



Avoidance bandwidth = 200 MHz

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Conclusion

- ✓ Full test procedure for DAA enabled UWB device ready for PE
- ✓ Two main modes of test
  - o Start-up test
  - o In operation test
- ✓ Preferred test method: radiated
- ✓ Complete set of random test pattern for radio location systems and BWA
- ✓ Optimized test time procedure
- ✓ Very low RX level of below -65dBm/MHz are not measureable in the test!

Annex

Victim signal generation - Radar

- Generation of different test bursts

Radar Test Frequencies (note 11)	Radar test signal	Pulse width W [µs] (see note 5)	Pulse repetition frequency f_{PRF} [pps] (note 13)	Pulses per burst [PPB] (see note 1 and note 12)	Burst repetition frequency f_{BRF} [bps]	Detection probability with 50 % channel load
f_1= 3.1GHz $f_1 < f_2 < f_3$ f_3= 3.4 GHz	1 – Variable	20, 30, 40	400 – 1 400 (see note 6)	10 – 60	0.2 – 0.08	P_d > 90 %
f_1= 3.1 GHz $f_1 < f_2 < f_3$ f_3= 3.4 GHz	2 – Variable	10, 20, 40, 60, 100	100 – 500 (see note 6)	2 – 5	0.2 – 0.08	P_d > 90 %
f_1= 8.55GHz $f_1 < f_2 < f_3$ f_3= 8.95GHz	3 – Variable	1, 2, 5, 10, 15	5000 – 15 000	20 – 560	2.0 – 0.22	P_d > 90 %

NOTE 1: This represents the number of pulses seen at the UWB DAA radio device per radar scan:
N = [{antenna beamwidth (deg)} × {pulse repetition rate (pps)}] / [{scan rate (deg/s)}].
Chose randomly a number of pulses in the given limits.
L = PPB*1/f_{PRF}. Burst length in seconds.

NOTE 2: The test signals above only contain a single burst of pulses.

NOTE 3: The number of pulses per burst given in this table simulates real radar systems and takes into account the effects of pulse repetition rate and pulse width on the detection probability for a single burst.

NOTE 4: P_d gives the probability of detection per simulated radar burst and represents a minimum level of detection performance under defined conditions – in this case a 50 % traffic load.
Therefore P_d does not represent the overall detection probability for any particular radar under real life conditions. In general 2 sequential bursts are needed to achieve a real life detection rate of better that 99 % for any radar that falls within the scope of this table.

NOTE 5: The pulse width used in these tests is assumed to be representative of real radar systems with different pulse widths and different modulations. The pulse width is assumed to have an accuracy of ± 10 %.

NOTE 6: Chose PRF randomly in the given range.

NOTE 7: The burst repetition frequency f_{BRF} is used in the In-Service Monitoring test setup.

NOTE 8: The radar test signals 1 and 2 are to be used for the DAA radio device test in the band 3,1GHz to 3,4GHz

NOTE 9: The radar test signals 3 are to be used for the DAA radio device test in the 8,5 GHz to 9 GHz

NOTE 10: Pulses have instantaneous bandwidth of 0.5, 1, 2 or 5 MHz. Modulation types can be LFM, BPSK.

NOTE 11: The Radar Test Frequency f_2 shall be arbitrarily chosen between the f_1 and f_3

NOTE 12: Suitable combinations of PPB and f_{BRF} are to be selected whereby for radar test signals 1 to 3, the minimum number of pulses per second are 2, 2/5 and 40 respectively. This clarifies note 1.

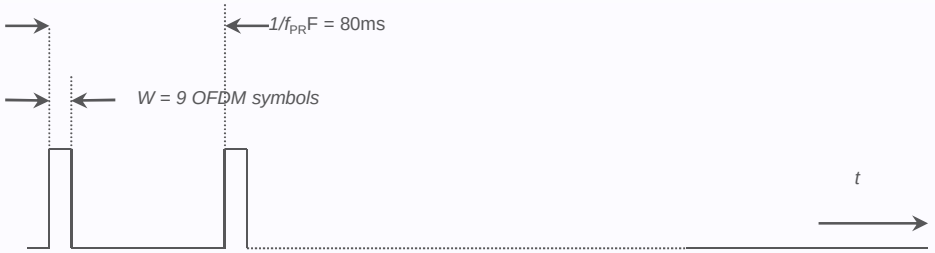
NOTE 13: The granularity for each radar test signal is 11 evenly distributed cases. The respective step sizes for radar test signals 1 to 3 are 100, 40 and 1 000.

Victim signal generation - Wimax

- ✓ Emulation of different service types

BWA:
Voip mode test pattern

BWA:
Web surfing mode test pattern



BWA:
Sleep mode & broadcast mode test pattern