Refresher Topics on Radio Equipment Directive

Agenda

- Who cares? Administrative Part
- Increase of Testing Efforts
- Self-Declaration,
  how to find a published Harmonised Standard
- Wireless Coexistence Basics: Receiver Robustness
- More than minimum Performance
- Wireless Coexistence: Adaptivity
- Further Discussion, Backup

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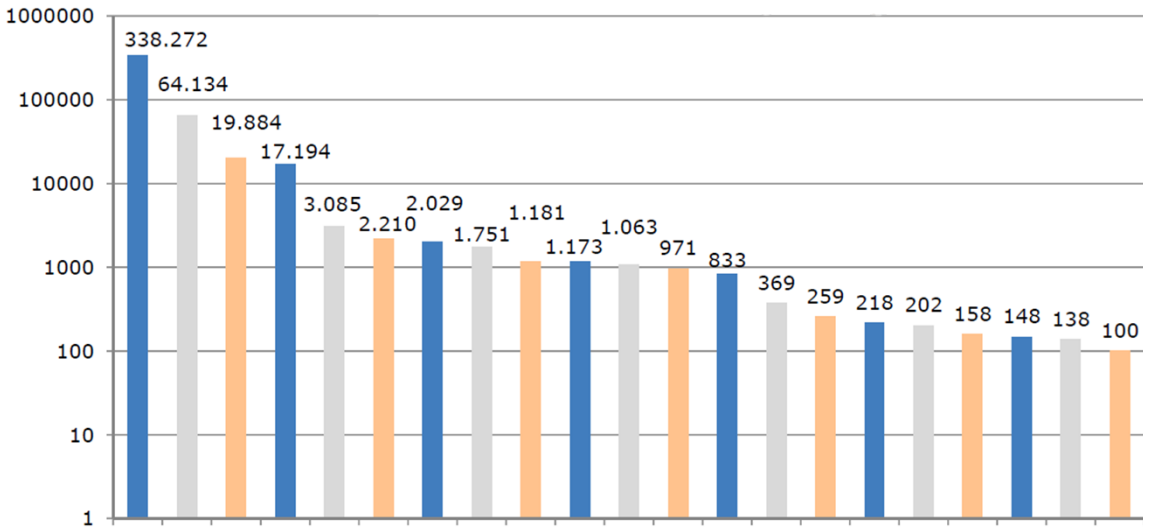
Who cares?

The individual regulator
per EU / EFTA / Candidate / MRA country
can decide market surveillance measures.

The combined group of regulators → e.g. TCAM
can run administrative cooperation campaigns.

Market Surveillance Example

German regulator - online trade interventions per product category

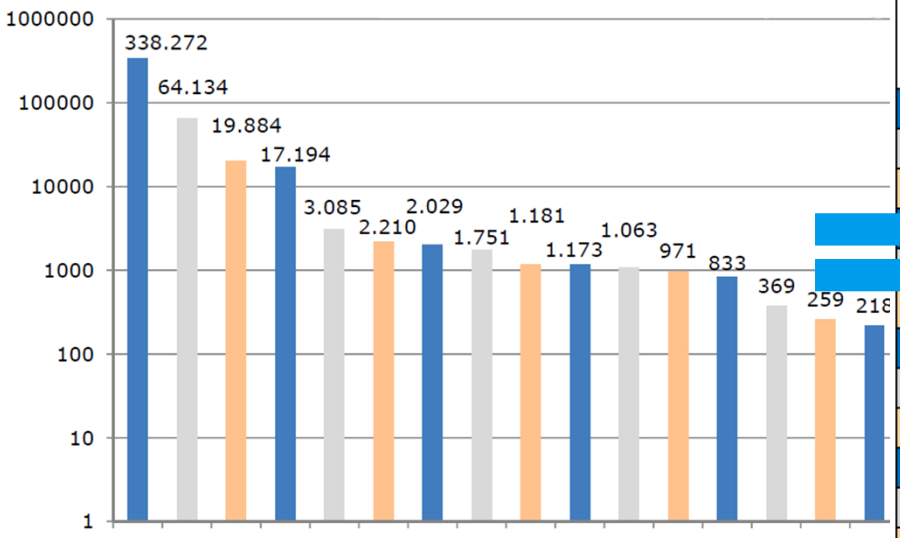


	Rank	Category	Stops of Online Sales
	1	Radio headphones	338,272
	2	Drones / Quadrocopters	64,134
	3	Smartwatches	19,884
	4	Radio transmitters (*e.g. portable FM Tx'*)	17,194
	5	Backup cameras	3,085
	6	Remote-controlled sockets	2,210
	7	Audio mixers	2,029
	8	Hand-held radios	1,751
	9	LED lamps	1,181
	10	e-cigarettes	1,173
	11	Surveillance cameras	1,063
	12	Radio door bells	971
	13	Mobile radios	833
	14	Radio alert systems	369
	15	Bluetooth applications	259
	16	others 1	218
	17	others 2	202
	18	Multimedia equipment	158
	19	Alarm clocks	148
	20	Game pads	138
	21	HDMI switches	100
	22	USB chargers	99
		others 3	284
			455,755

Source: BundesNetzAgentur.
Statistik Marktüberwachung 2017

Market Surveillance Example

German regulator - online trade interventions per product category



Source: BundesNetzAgentur.
Statistik Marktüberwachung 2017

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18	Multimedia equipment	158
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Be aware of Market Surveillance by TCAM / ADCO

Telecommunication Conformity Assessment and Market Surveillance

TCAM

Regulators of…
EU states +
EFTA states +
„candidates“ + ?UK?

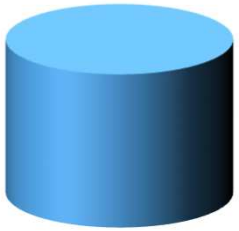
Each regulator can
decide on random checks up to
10 years after market placement
and may ask for

- Test reports
- Declaration of Conformity
- Purchase of radio equipment
- Test of radio equipment
- Notes and calculations done during the risk assessment

Is there a mismatch?
Is there something strange?

Joint Actions

Committee work,
around 3 meetings
per year.



Common Data
including black-list

Administrative Cooperation - RED

ADCRED

- Trials
- Cross-border surveillance Campaigns
- Conformity assessment cooperation

Extra:

Administrative Cooperation - EMC

No harmonisation on sanctions among the states.

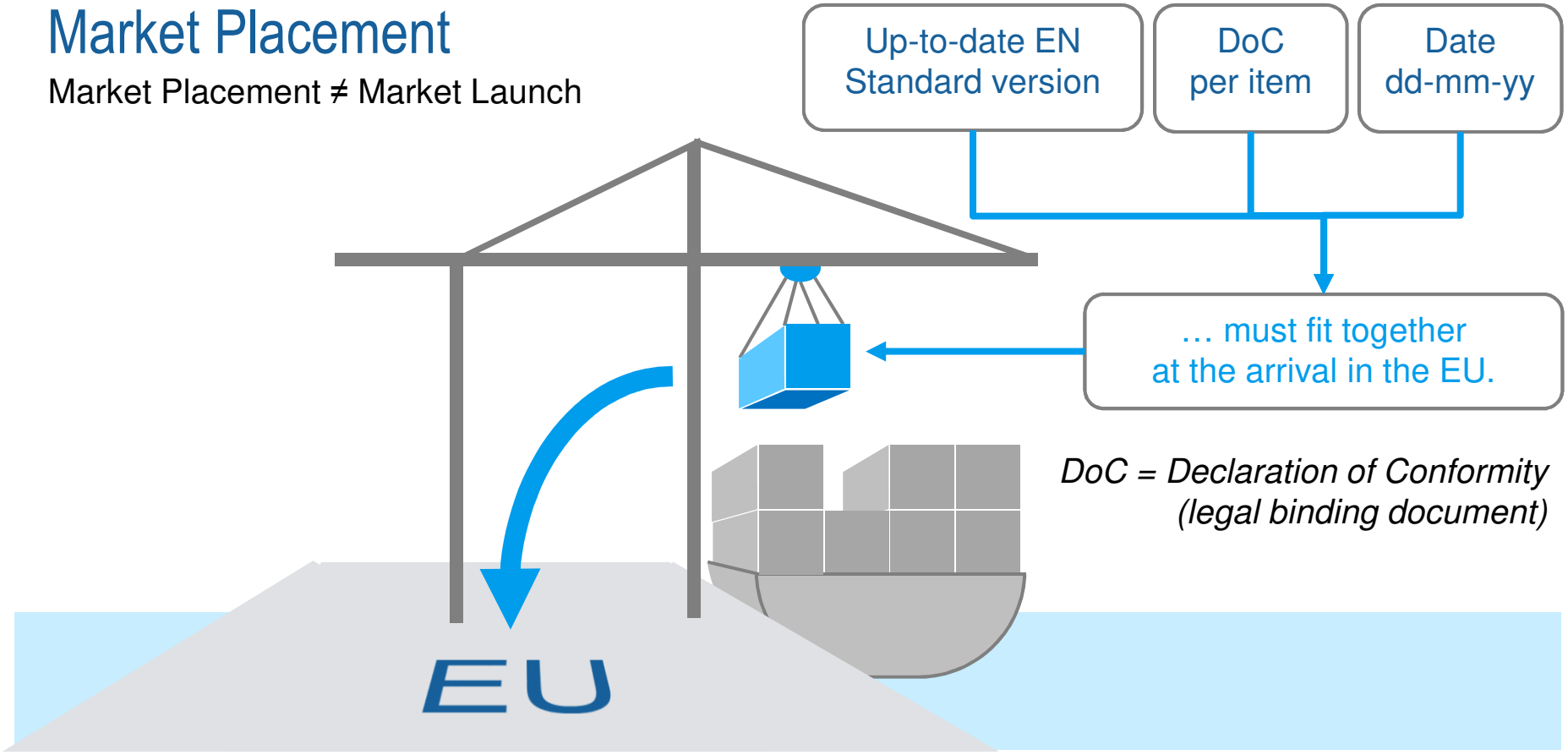
No Harmonisation on Sanctions among the States.

- Germany: Funkanlagengesetz („Law of Radio Equipment“)
  - Formal error → 10 kEUR
  - Test chapters omitted on purpose → 100 kEUR
  - Valid standard version omitted → 100 kEUR

- Switzerland
  - In case of imports: private persons can be sewed
    - 1st time: 3000 CHF fine
    - Follow up in the media
  - Fulfillment centers are not responsible

Market Placement

Market Placement ≠ Market Launch



DoC = Declaration of Conformity
(legal binding document)

Manufacturer‘s Homework according RED

Declaration of Conformity

Manufacturer
(sole responsible)

DoC

Annex VI

including dated reference to..
harmonized standard or
to other technical specification

EU +
EFTA +
„Candidates“

Notified bodies can be approached for testing, conformity assessment.
NBs must be registered with a number and listed in the „NANDO“ list

Precisley identified combination of radio equipment and software

Combination of Radio Equipment & Software

Conformity Assessment

Precondition | Result =DoC

Art. 17

- Documentation
- Test Reports
- Solutions adopted to meet the essential requirements
- and more

Risk Assessment

DoC = Declaration of Conformity

RED Art. 3

Essential Requirements of Art. 3 are met

yes no

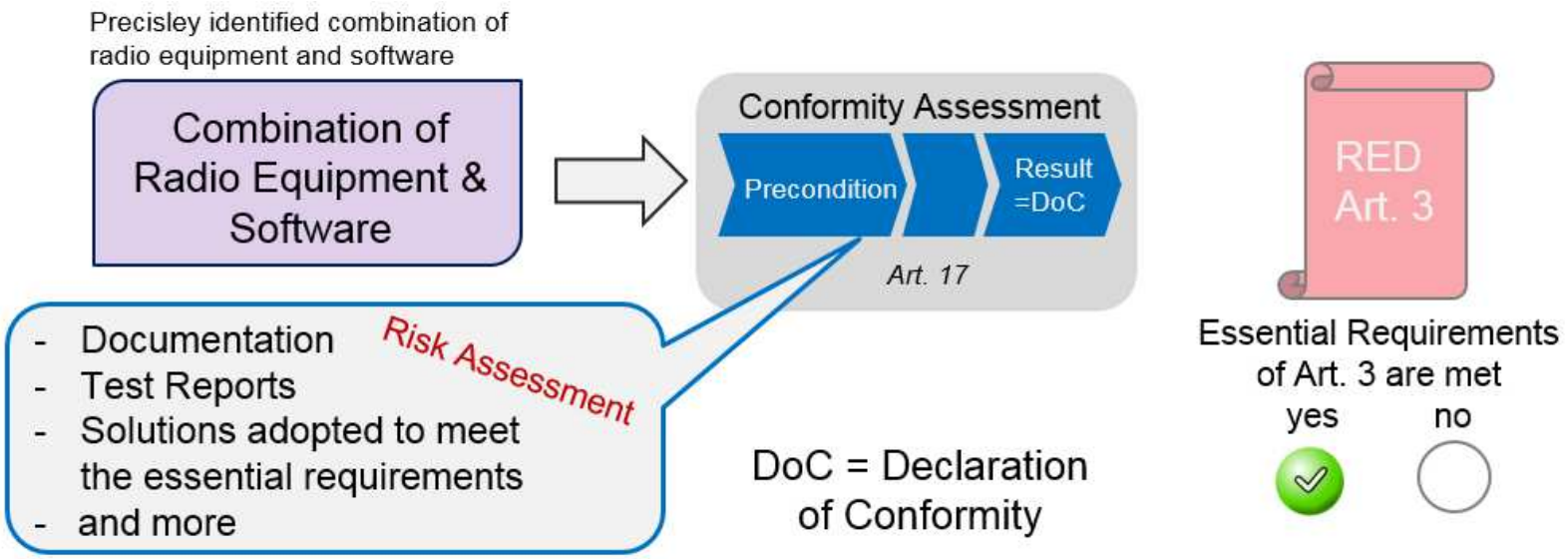
The complete set of documents is ready for an audit-like assessment. Rentention period 10 years

yes *no*

The DoC stands at the end of the Conformity Assessment Procedure.

Declaration of Conformity

The Declaration of Conformity marks the end of a process



The DoC stands at the end of the Conformity Assessment Procedure.

Declaration of Conformity - Example taken from a Camera

Manufacturer Name
and address

Reference Number

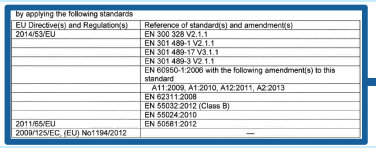
EU Declaration of Conformity

This declaration is issued under the sole responsibility of the manufacturer

We declare, that the product
<xyz>
is in conformity with the essential requirements of EU directive(s)

by applying the following standards

EU Directive(s) and Regulation(s)	Reference of standard(s) and amendment(s)
2014/53/EU	EN 300 328 V2.1.1
	EN 301 489-1 V2.1.1
	EN 301 489-17 V3.1.1
	EN 301 489-3 V2.1.1
	EN 60950-1:2006 with the following amendment(s) to this standard
	A11:2009, A1:2010, A12:2011, A2:2013
	EN 62311:2008
	EN 55032:2012 (Class B)
	EN 55024:2010
2011/65/EU	EN 50581:2012
2009/125/EC, (EU) No1194/2012	—



Date: _____

_____
Signature

On the radio part…

self-declaration is possible as soon as a harmonised standard is published in the Official Journal of the EU.

See the legally binding statement in the DoC!

Refresher Topics on Radio Equipment Directive

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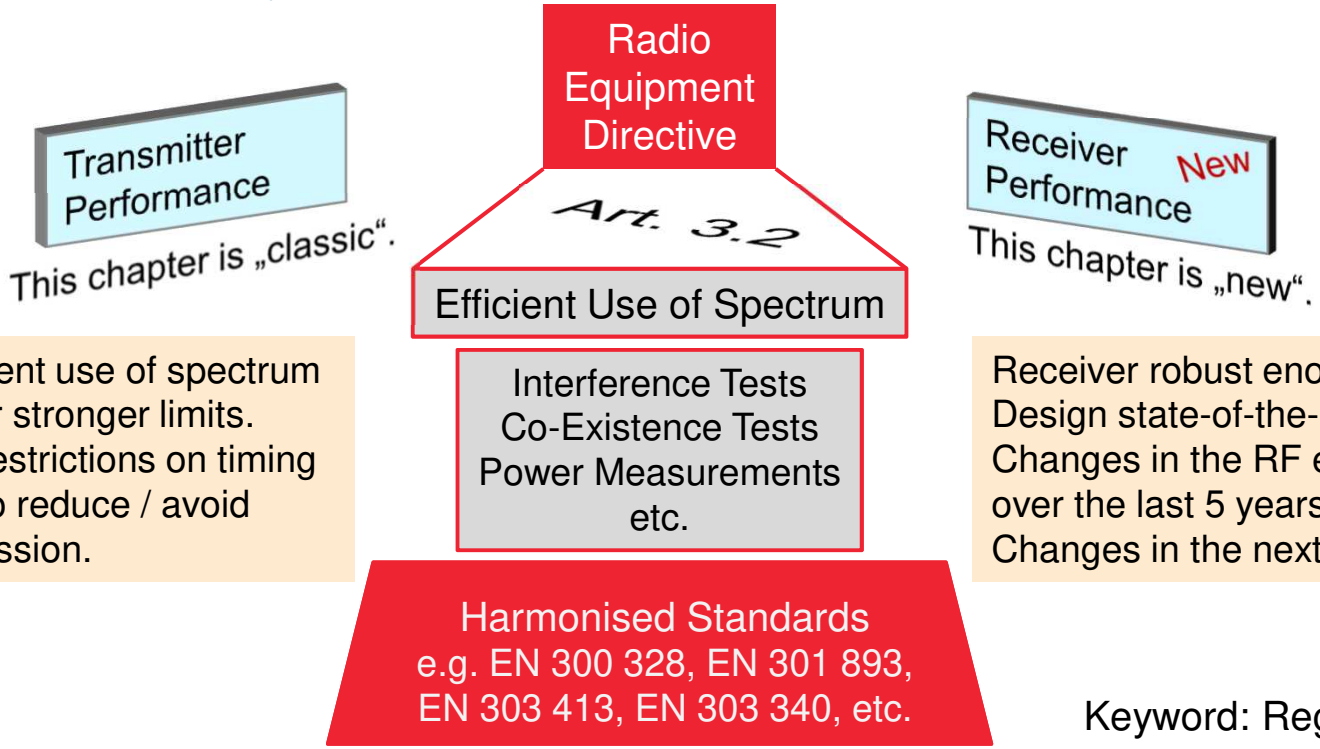
RED: Radio Equipment Directive

2014/53/EU: mandatory since June 2017



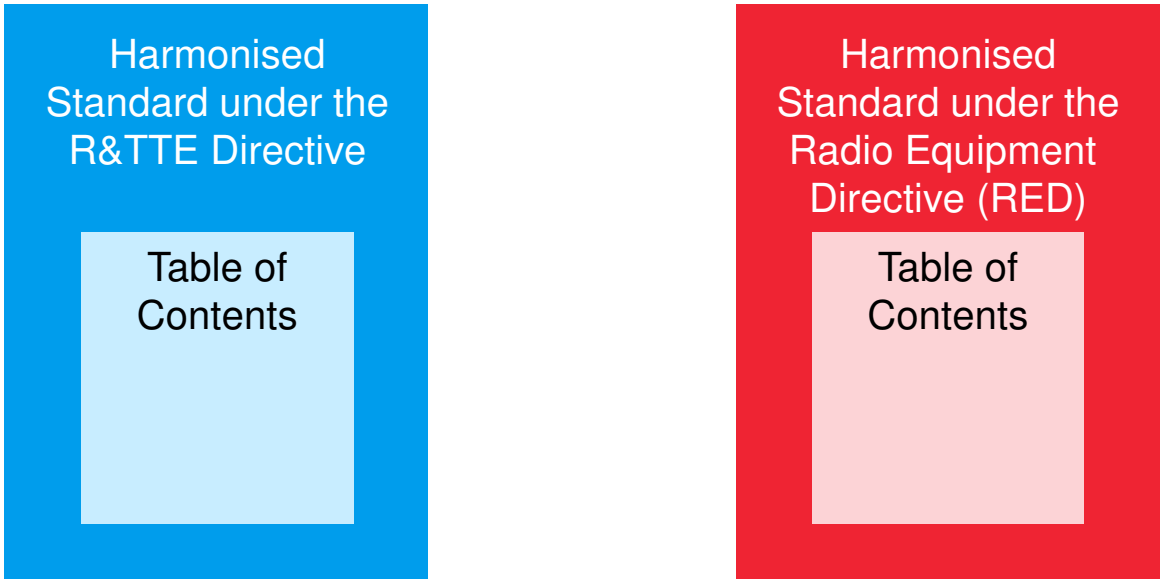
More efficient use of spectrum can call for stronger limits.
Stronger restrictions on timing behavior to reduce / avoid signal collission.

Receiver robust enough?
Design state-of-the-art?
Changes in the RF environment over the last 5 years?
Changes in the next few years?

Keyword: Regulatory Testing

Increase of Testing Efforts

Check the standard versions:
The table of contents is a good indicator for testing efforts.



Increase of Testing Efforts

Example: EN 302 567 under Directive 1999/5/EC (R&TTE)

Example:
„WIGIG“ Standard
under R&TTE

Chapter 5 of a harmonised EN standard under RED (article 3.2) describes the test procedures. The chapter 5 can be taken as a measure of testing efforts.
Take a look at the chapter 5 when changing from R&TTE (old regulatory regime) to RED (new regulatory regime). You can do this kind of effort comparison with any harmonized EN standard that existed under R&TTE.

Increase of Testing Efforts

Example: EN 302 567 under Directive 1999/5/EC (R&TTE)

Example:
„WIGIG“ Standard
under R&TTE

Increase of Testing Efforts

Example: EN 302 567 under Directive 2014/53/EU (RED)

Example:
„WIGIG“ Standard
under RE-Directive

Extended table of contents in the standard

More requirements

Increase of Testing Efforts

Example:
2.4 GHz ISM

			for TX	for RX
EN 300 328 under R&TTE				
Chapter 5	Essential Test Suites	from page 35 to page 66 total 32 pages	from page 35 to 63 in total 29 pages	from page 64 to page 66 in total 3 pages
EN 300 328 under RED				
Chapter 5	Testing for compliance with technical requirements	from page 39 to 74 in total 36 pages	from page 39 to 69 in total 31 pages	from page 70 to 74 in total 5 pages

Independent from the title the chapter 5 contains the test process steps. More steps mean more efforts.

Self-Declaration,
how to find a published Harmonised Standard

Agenda

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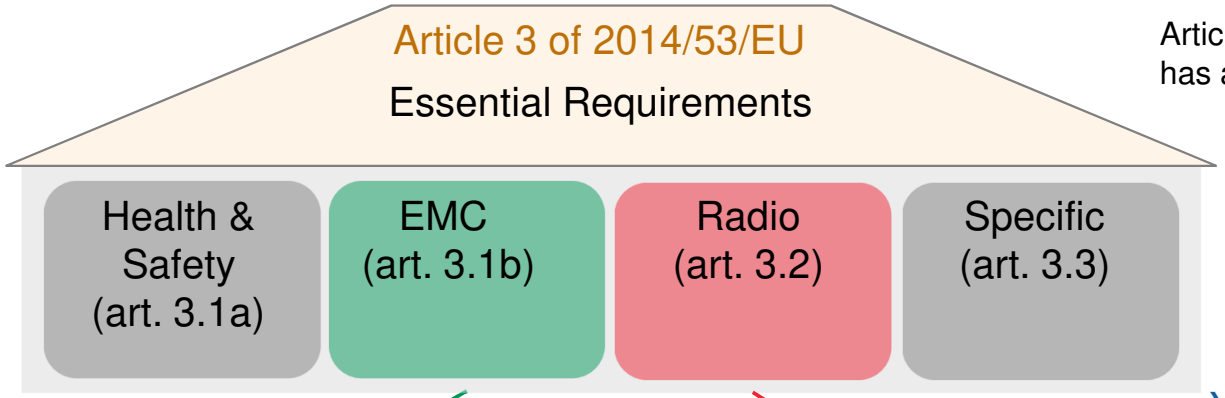
Is Self-Declaration possible?



Article 3 of the RED has an „umbrella“ function.

YES for 3.1b, if…

… the radio equipment complies to an applicable harmonized EMC standard with reference to art. 3.1 of directive 2014/53/EU then the radio equipment is presumed to be in conformity with the essential requirements set out in article 3.1 b of the RED.

For the EMC part, self-declaration is always possible.

YES for 3.2, if…

… the radio equipment complies to an applicable harmonized standard with reference to art. 3.2 of directive 2014/53/EU then the radio equipment is presumed to be in conformity with the essential requirements set out in article 3.2 of the RED.

For the Radio part, self-declaration is possible, if the applicable EN standard is listed in the Offical Journal (EU). Outsourcing of tests possible.

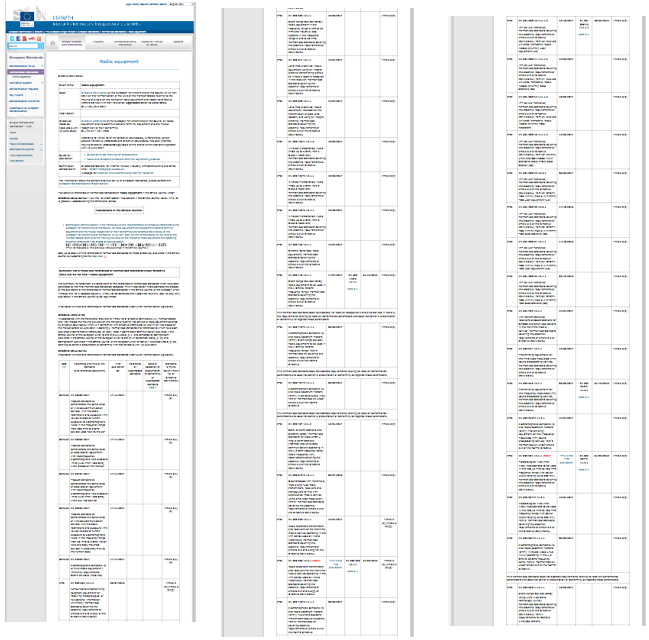
How to check the status „published“ of a standard?

http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/red_en

[CTRL]+[F] <your EN number>

ETSI	EN 303 413 V1.1.1 **(new)** Satellite Earth Stations and Systems (SES); Global Navigation Satellite System (GNSS) receivers; Radio equipment operating in the 1 164 MHz to 1 300 MHz and 1 559 MHz to 1 610 MHz frequency bands; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU	This is the first publication			Article 3(2)

A long list….



Up-to-date Harmonised Standards refer to 2014/53/EU

Reference on title page of standard
Old versions of Harmonised Standards refer to Directive 1999/5/EC
Up-to-date Harmonised Standards refer to Directive 2014/53/EU.

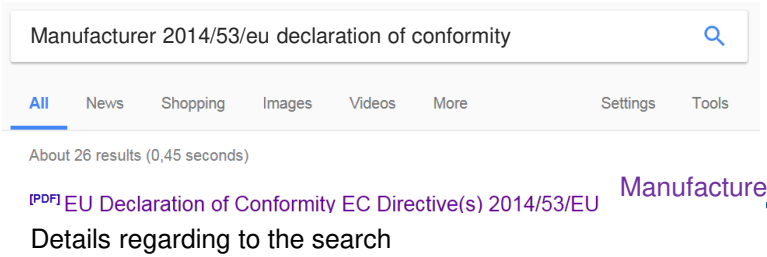
EN 3xx xxx Version Number (Date)

Chapter / Title / EUT Type

Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

How to find an example of a Declaration of Conformity?

Search: <manufacturer name> + 2014/53/EU + Declaration of Conformity



Manufacturer

EU Declaration of Conformity

EC Directive(s)	**2014/53/EU**
Manufacturer	Manufacturer Details Product Details
Radio Equipment	
Description / Intended Use	**Narrow Band 1.75 / vehicular radar utilized for object detection applications**
Article 3.2: Applied Radio Spectrum Standard(s)	**EN 302 858 v2.1.1 (2016-12)**
Article 3.1(b): Applied EMC Standard(s)	**EN 301 489-1 v1.9.2 (2011-09), EN 301 489-1 v2.1.1 (2017-03), EN 301 489-3 v2.1.0 (2017-03)**
Article 3.1(a): Applied Health and Safety Standard(s)	**EN 60950-1: 2006 / A2:2013, EN 62479:2010, EN 62311:2008**
Frequency band(s) in which the radio equipment operates	Transceive: **24.05 – 24.25 GHz**
Maximum radio-frequency power transmitted	**Category D – < 20 dBm peak EIRP**

Hereby, Manufacturer Inc. declares, that the object described above is in conformity with the Directive 2014/53/EU.
This declaration is issued under the sole responsibility of the manufacturer

Signature

Which standards are listed under „Article 3.2“?

In this example:
EN 302 858 V 2.1.1

How to find an example of a Declaration of Conformity?

Search: <manufacturer name> + 2014/53/EU + Declaration of Conformity

Manufacturer

EU DECLARATION of CONFORMITY (DoC)

(No. 11[redacted])

This declaration of conformity is issued under the sole responsibility of the manufacturer:

Name:
Address:

We declare that the DoC is issued under our sole responsibility and belongs to the following product.

Object of the declaration:

Product Name Car audio with DAB radio,

Model Name

Software Ver.

Accessories N/A

The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

Radio Equipment (RE) Directive (2014/53/EU)

The following harmonized standards and technical specifications have been applied:

Health & Safety (Article 3.1(a)):	EN 60065:2014
EMC (Article 3.1(b)):	EN 301 489-1 V2.1.1 EN 301 489-3 V2.1.0 (Draft)
Radio Spectrum (Article 3.2):	EN 303 345 V1.1.1 (Draft)

Notified Body performed an EU-type examination in accordance with the requirements of Annex III of RE Directive and issued the EU-type examination certificate.

Notified Body:
UL Japan, Inc. (No. 1731)
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021, Japan

Certificate No.: ULA[redacted]

Signed for and on behalf of:

Place of Issue:

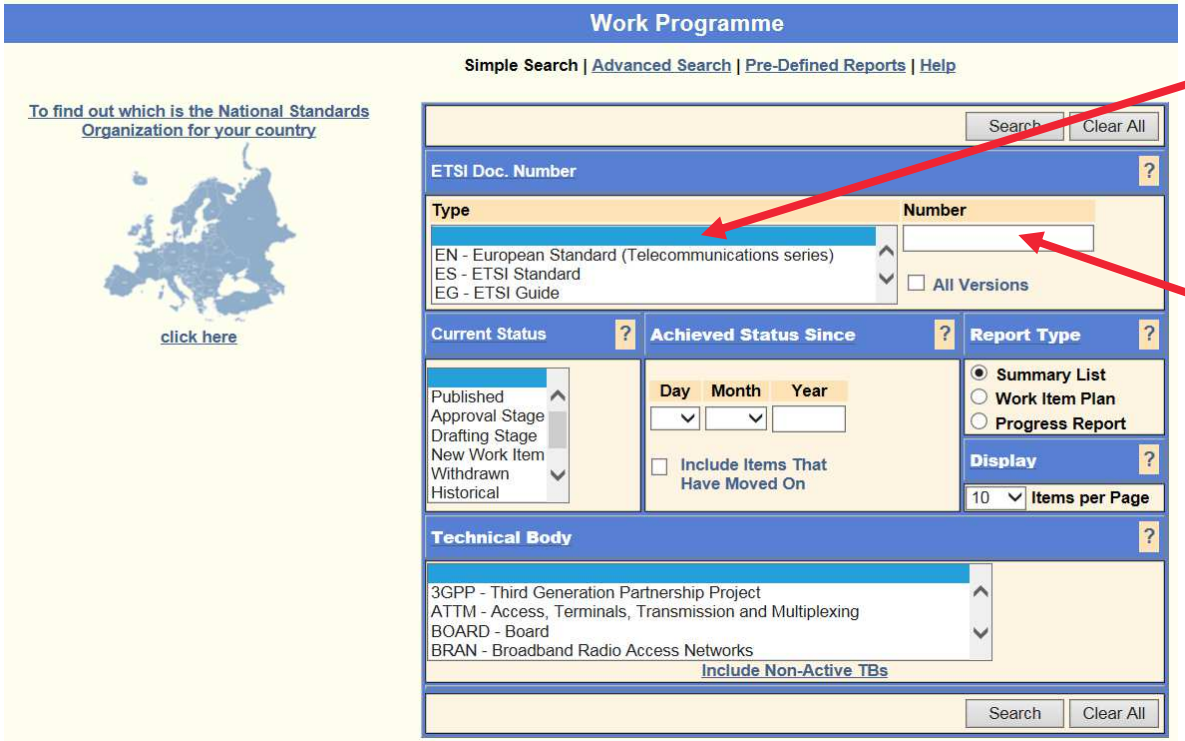
Date of Issue:

General Manager
Engineering Div.

How to find the „right“ standard version?

Search in the ETSI-Portal – Search – Work Programme

5a



Select prefix „EN“

Enter the number:
3 digits
„space“
3 digits:

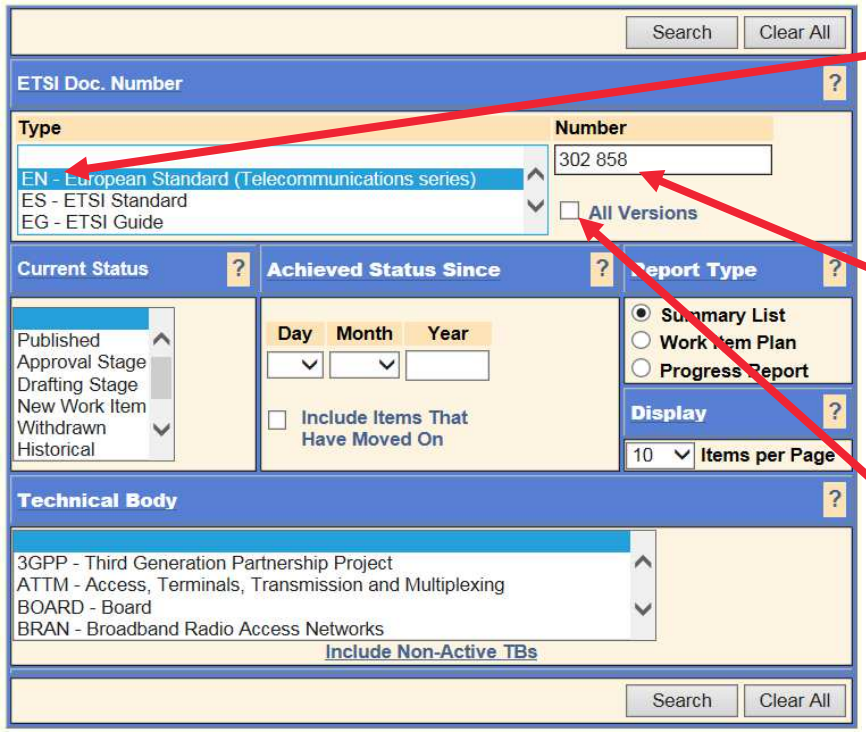
302 858

Screenshots taken from ETSI.org

How to find the „right“ standard version?

Search in the ETSI-Portal – Search – Work Programme

5b



Select prefix „EN“

Enter the number:
3 digits
„space“
3 digits:

302 858

Activate all versions

How to find the „right“ standard?

Search in the ETSI-Portal – Search – Work Programme

6

2017-08-02 **Work Programme** Version 2.3.3

Simple Search | Advanced Search | Pre-Defined Reports | Help

Work Items with ETSI Document Number of '302 858' of Type 'EN'

View As Work Item Plan | View As Work Item Progress Report

Found **4** Items...
Displaying items **1** to **4** ...

	IDENTIFICATION	TITLE	STATUS
1 FINALIZED	Doc. Nb. EN 302 858-2 Ver. **1.3.1** Ref. **REN/ERM-TGSRR-061-2** Technical Body: ERM TGSRR Directives: **2014/53/EU** Details and Download	**Electromagnetic compatibility and Radio spectrum Matters (ERM);** **Road Transport and Traffic Telematics (RTTT); Automotive radar equipment operating in the 24,05 GHz up to 24,25 GHz or 24,50 GHz frequency range;** **Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive** EN for NB SRR @ 24GHz	**Published** Current Status: Citation in the OJ (2017-06-08)
2 FINALIZED	Doc. Nb. EN 302 858-2 Ver. **1.3.1** Ref. **REN/ERM-TGSRR-061-2_R&TTE** Technical Body: ERM TGSRR Directives: **99/5/EC** Details and Download	**Electromagnetic compatibility and Radio spectrum Matters (ERM);** **Road Transport and Traffic Telematics (RTTT); Automotive radar equipment operating in the 24,05 GHz up to 24,25 GHz or 24,50 GHz frequency range;** **Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive** EN for NB SRR @ 24GHz	**Published** Current Status: No more cited in the OJ (2017-06-13)
3 FINALIZED	Doc. Nb. EN 302 858-1 Ver. **1.3.1** Ref. **REN/ERM-TGSRR-061-1** Technical Body: ERM TGSRR Details and Download	**Electromagnetic compatibility and Radio spectrum Matters (ERM);** **Road Transport and Traffic Telematics (RTTT); Automotive radar equipment operating in the 24,05 GHz up to 24,25 GHz or 24,50 GHz frequency range;** **Part 1: Technical characteristics and test methods** EN for NB and WLAM SRR @ 24GHz	**Published** Current Status: Publication (2013-11-22)
4 FINALIZED	Doc. Nb. EN 302 858 Ver. **2.1.1** Ref. **REN/ERM-TGSRR-77** Technical Body: ERM TGSRR Directives: **2014/53/EU** Details and Download	**Short Range Devices; Transport and Traffic Telematics (TTT);** **Radar equipment operating in the 24,05 GHz to 24,25 GHz or 24,05 GHz to 24,50 GHz range;** **Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU** vehicular radar operating in 24 GHz NB range	**Published** Current Status: Delivery to the EC (2016-12-12) Next Status: Citation in the OJ (2017-03-06)

Found **4** Items...
Displaying items **1** to **4** ...
New Query

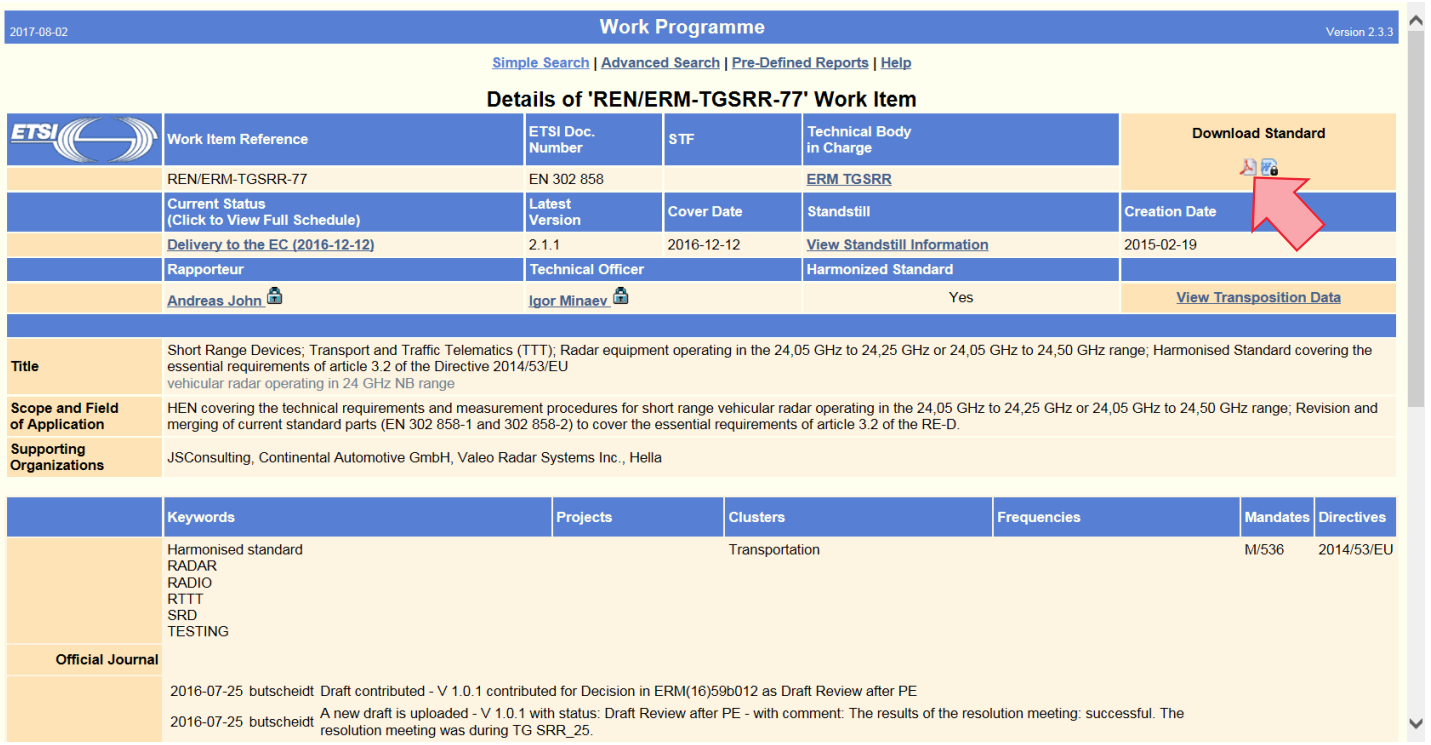
Any comments or problems with this application? Please let us know...

https://portal.etsi.org/webapp/WorkProgram/PreDefinedReports/QueryForm.asp

How to find the „right“ standard?

Search in the ETSI-Portal – Search – Work Programme

7



2017-08-02 **Work Programme** Version 2.3.3

Simple Search | Advanced Search | Pre-Defined Reports | Help

Details of 'REN/ERM-TGSRR-77' Work Item

	Work Item Reference	ETSI Doc. Number	STF	Technical Body in Charge	Download Standard
	REN/ERM-TGSRR-77	EN 302 858		ERM TGSRR	
	Current Status (Click to View Full Schedule)	**Latest Version**	**Cover Date**	**Standstill**	**Creation Date**
	Delivery to the EC (2016-12-12)	2.1.1	2016-12-12	View Standstill Information	2015-02-19
	Rapporteur	**Technical Officer**		**Harmonized Standard**	
	Andreas John	Igor Minaev		Yes	View Transposition Data

Title	Short Range Devices; Transport and Traffic Telematics (TTT); Radar equipment operating in the 24,05 GHz to 24,25 GHz or 24,05 GHz to 24,50 GHz range; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU vehicular radar operating in 24 GHz NB range
Scope and Field of Application	HEN covering the technical requirements and measurement procedures for short range vehicular radar operating in the 24,05 GHz to 24,25 GHz or 24,05 GHz to 24,50 GHz range; Revision and merging of current standard parts (EN 302 858-1 and 302 858-2) to cover the essential requirements of article 3.2 of the RE-D.
Supporting Organizations	JSConsulting, Continental Automotive GmbH, Valeo Radar Systems Inc., Hella

	Keywords	Projects	Clusters	Frequencies	Mandates	Directives
	Harmonised standard RADAR RADIO RTTT SRD TESTING		Transportation		M/536	2014/53/EU
Official Journal						
	2016-07-25 butscheidt Draft contributed - V 1.0.1 contributed for Decision in ERM(16)59b012 as Draft Review after PE 2016-07-25 butscheidt A new draft is uploaded - V 1.0.1 with status: Draft Review after PE - with comment: The results of the resolution meeting: successful. The resolution meeting was during TG SRR_25.					

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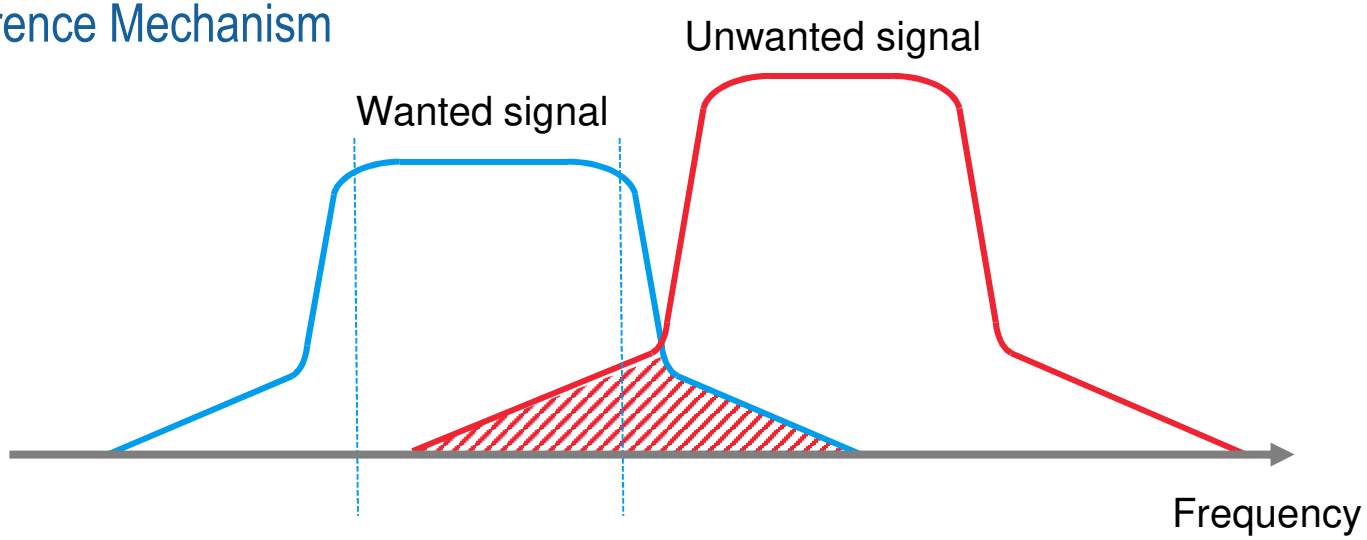
Wireless Coexistence

Interference Mechanism

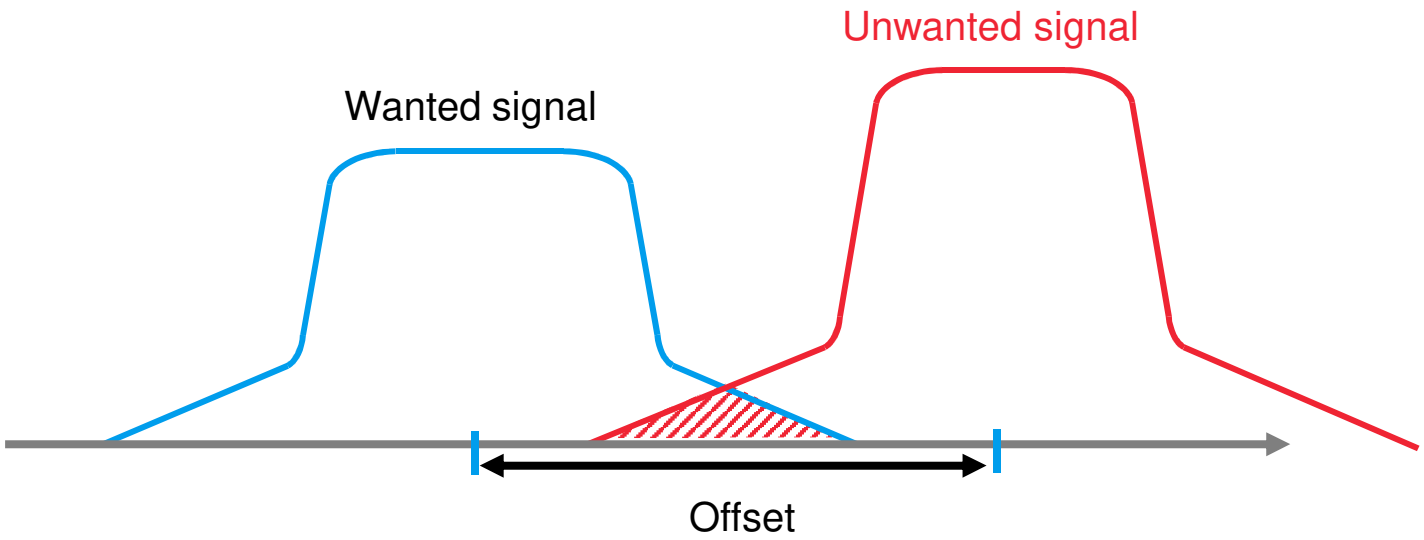


Pattern area: overlap translates into an increased noise level on the wanted receiver side.

Unwanted signal adjacent to wanted signal

Wireless Coexistence

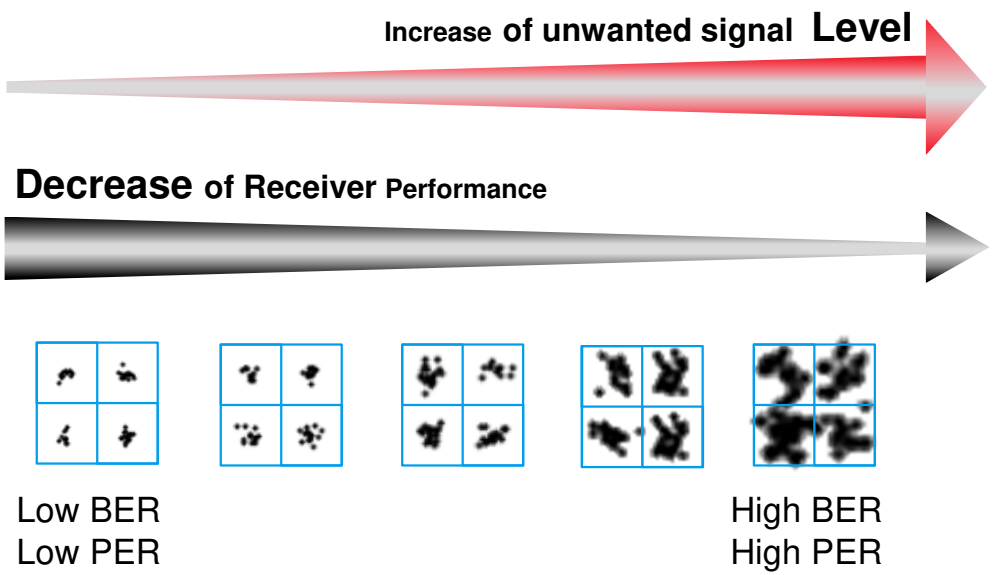
Interference Mechanism



Pattern area: overlap translates into an increased noise level on the wanted receiver side.

Unwanted signal with offset to wanted signal

Receiver under Interference Condition



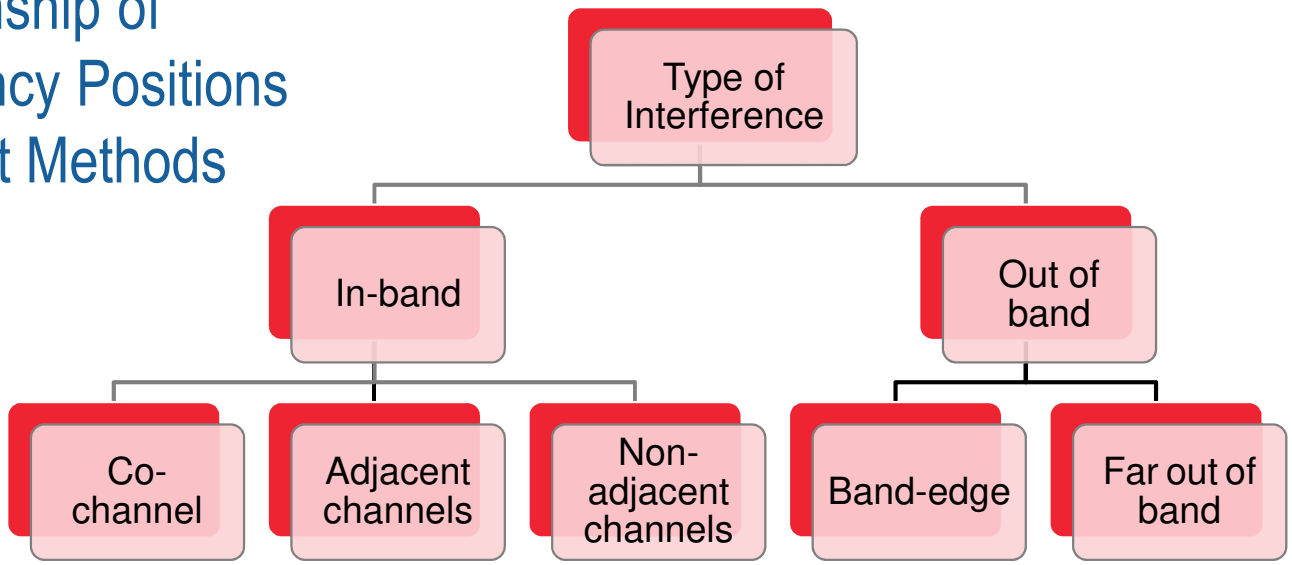
Wanted signal receiver
= receiver under interference conditions:

Can the receiver handle the interference and provide with a good performance?

Does the receiver ask for retransmission again and again while the already transmitted data is wasted (pure design)?

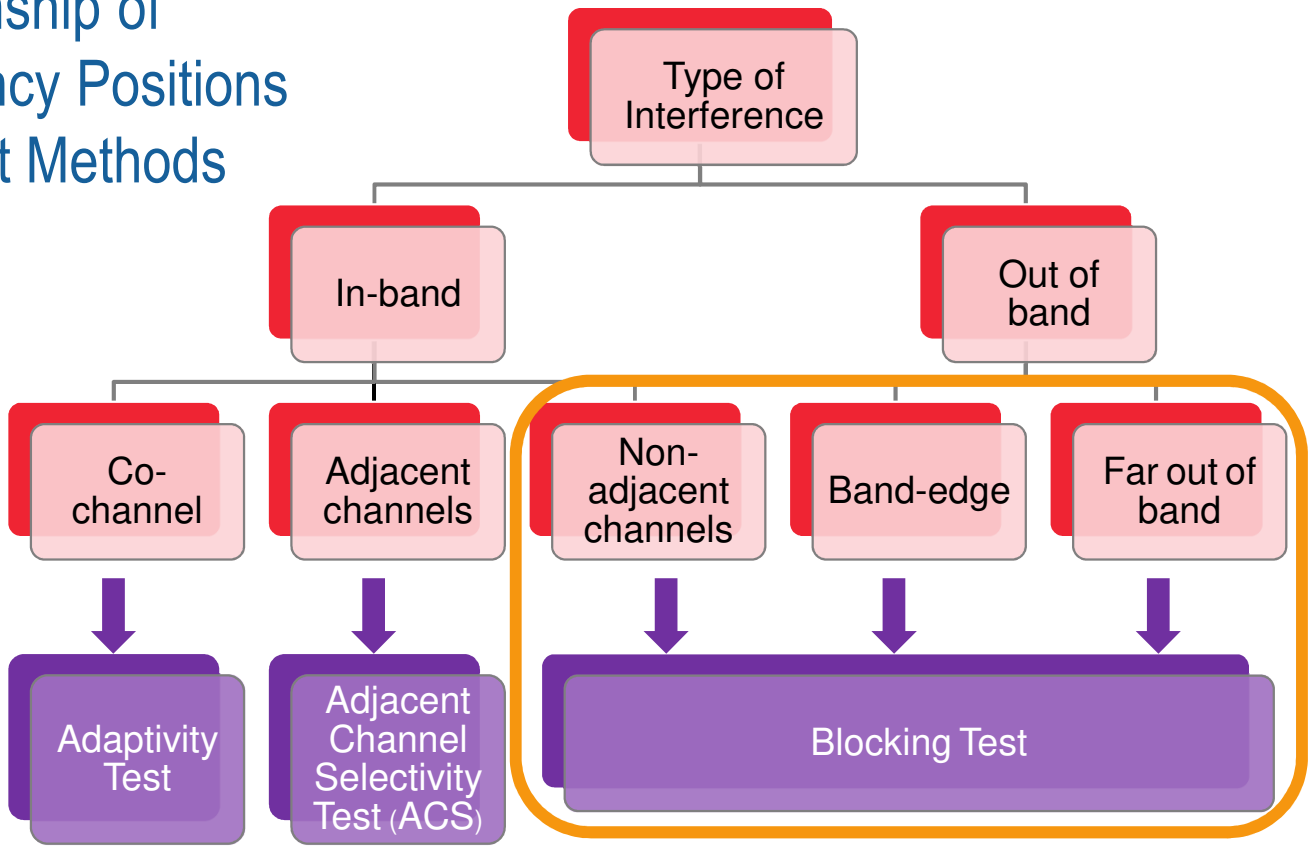
Does the receiver support for example a HARQ process and therefore asks for re-transmissions only when necessary (advanced design)?

Relationship of Frequency Positions and Test Methods



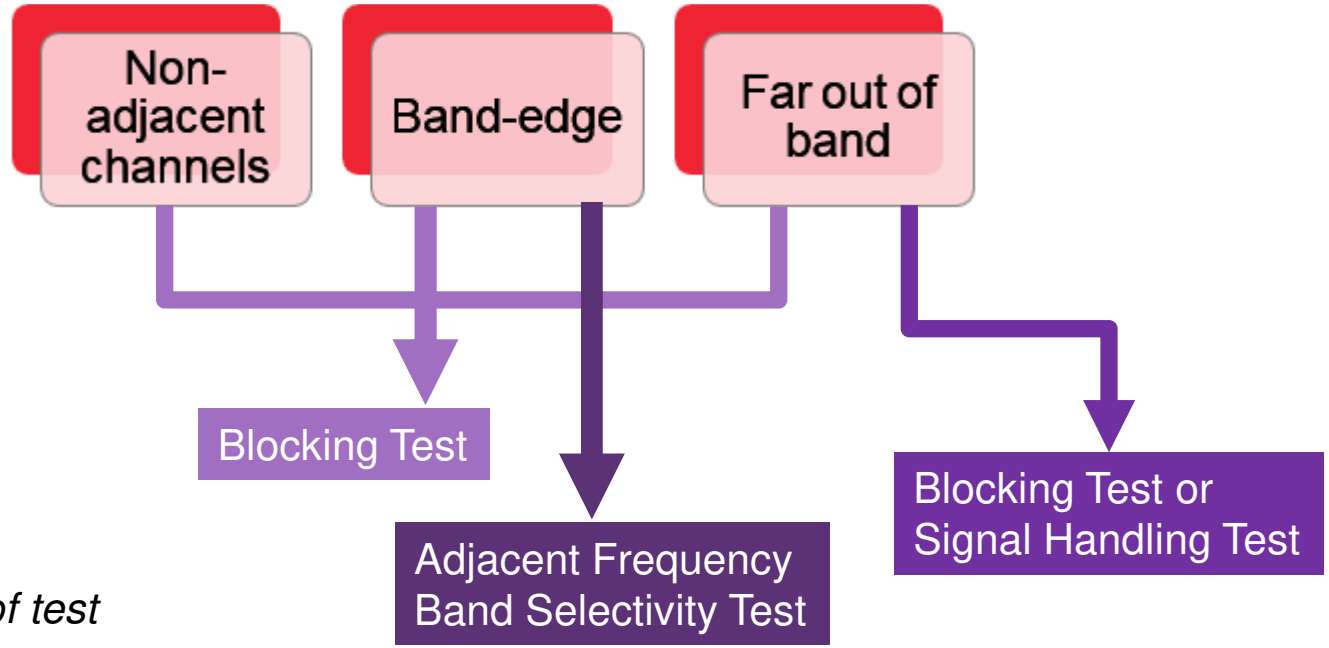
Picture based on an idea from IEEE Std. 1900.2

Relationship of Frequency Positions and Test Methods



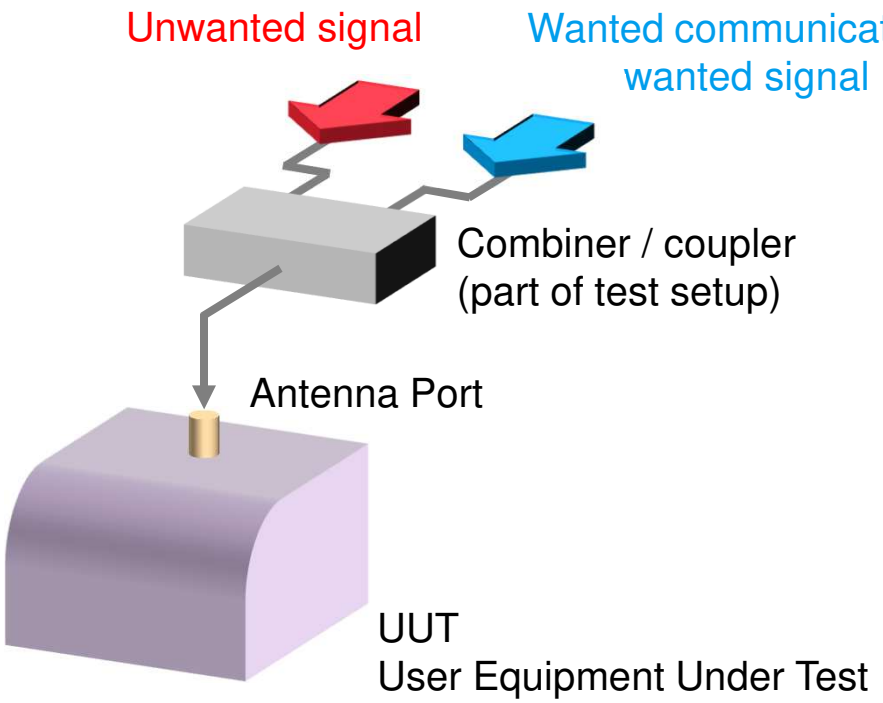
Picture based on an idea from IEEE Std. 1900.2

Relationship of Frequency Positions and Test Methods



Different names for the same principle of test

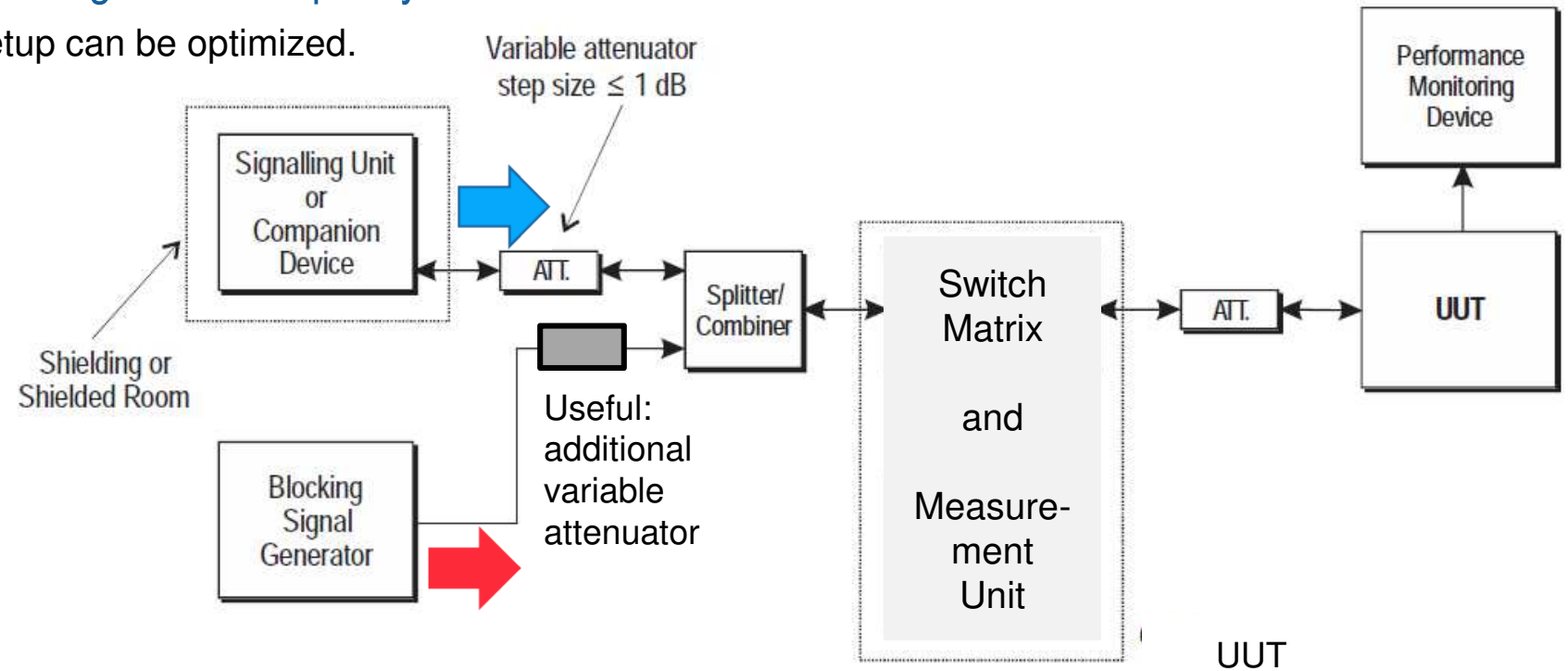
Receiver under Interference Condition



Receiver under Interference Condition

Blocking Test Example by ETSI BRAN

Setup can be optimized.

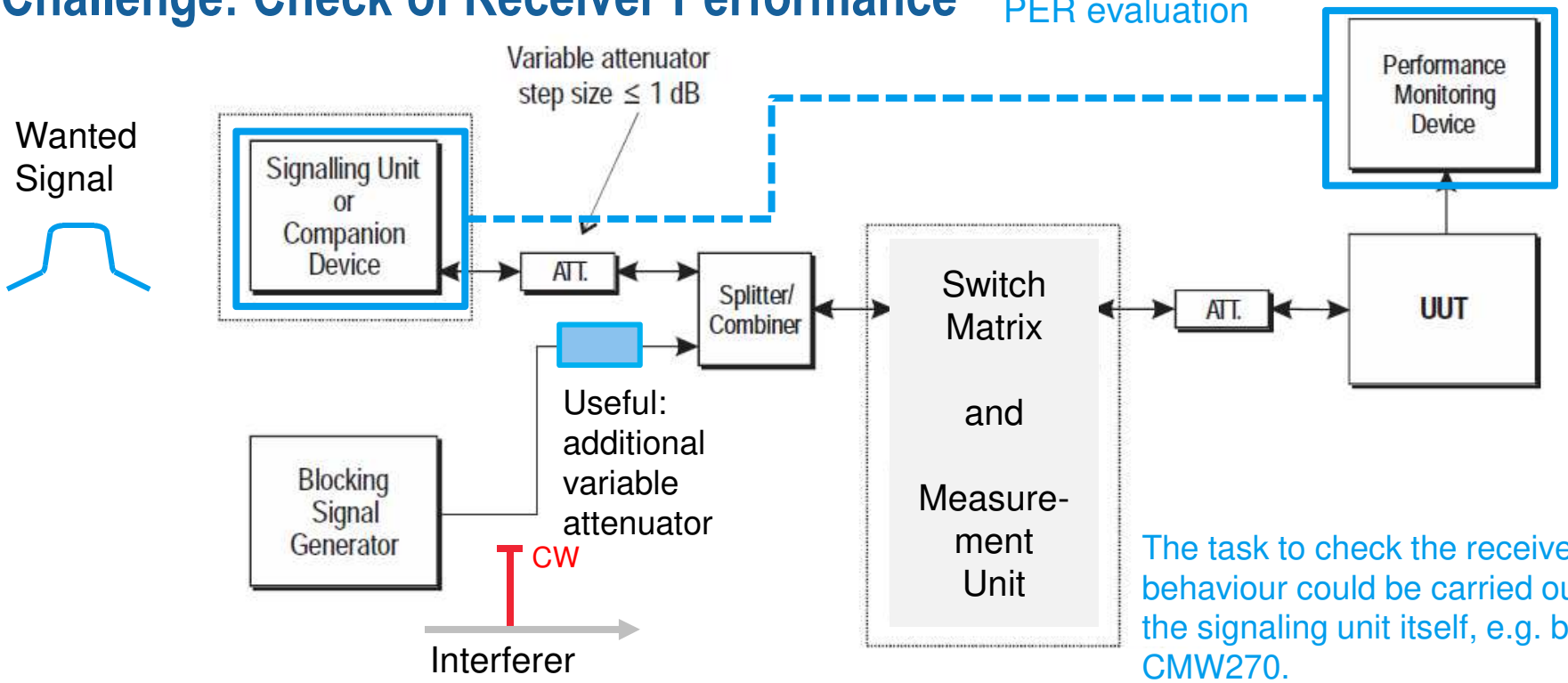


Picture from ETSI TS 103 521 v 1.1.1 with modification

UUT
User Equipment Under Test

Blocking Test in EN 301 893:
Challenge: Check of Receiver Performance

Tasks handled by signaling unit
e.g. by CMW270 during blocking test
PER evaluation

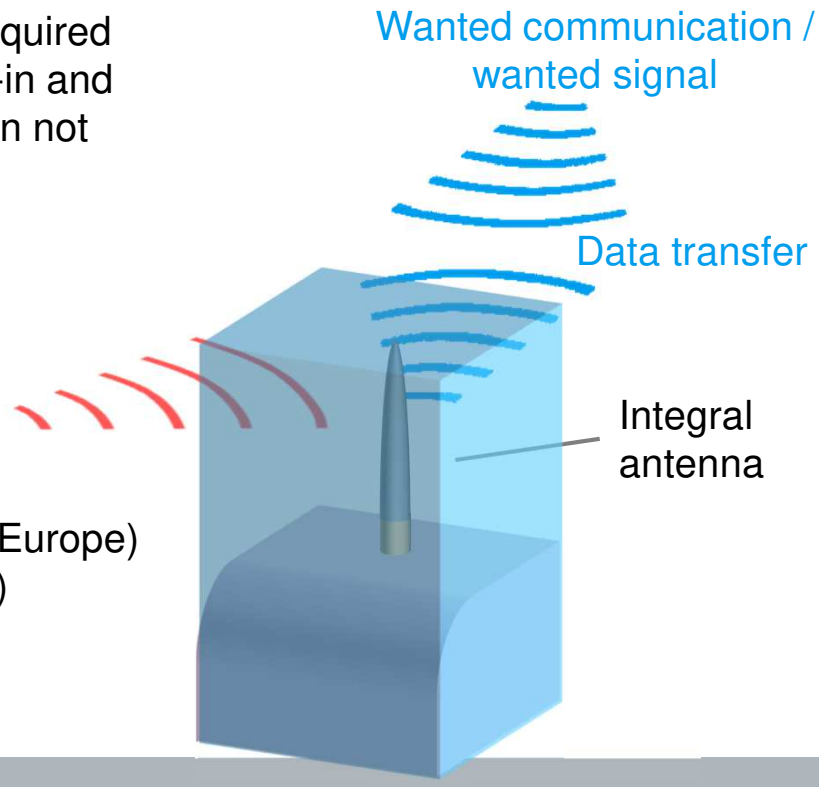


The task to check the receiver behaviour could be carried out by the signaling unit itself, e.g. by CMW270.

RED Approach allows Wireless Coexistence Tests

Radiated Test

Radiated testing is required if the antenna is built-in and if the antenna port can not be reached.
Suggestion:
immunity test system

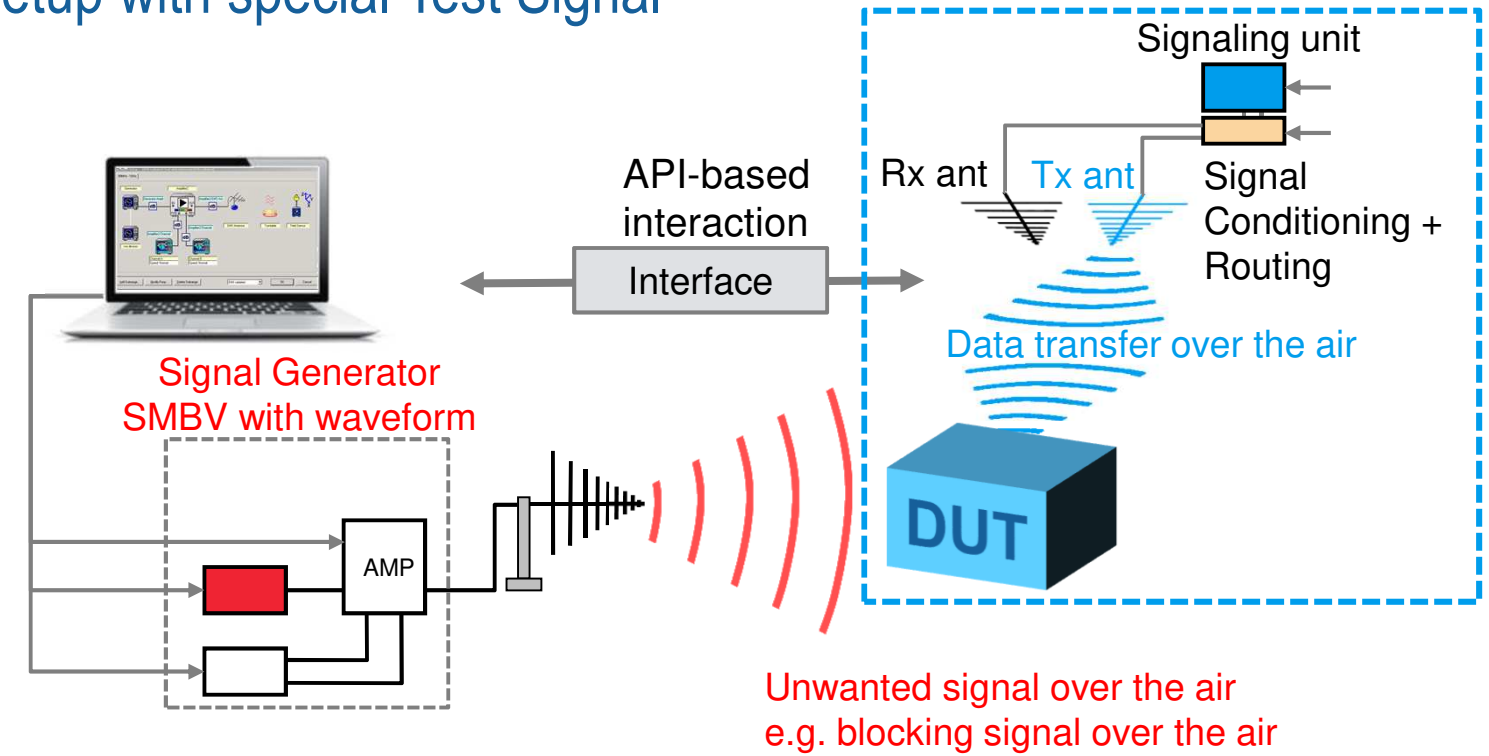


Waveform,
LTE uplink (FDD7 Europe)
LTE TDD 41 (USA)

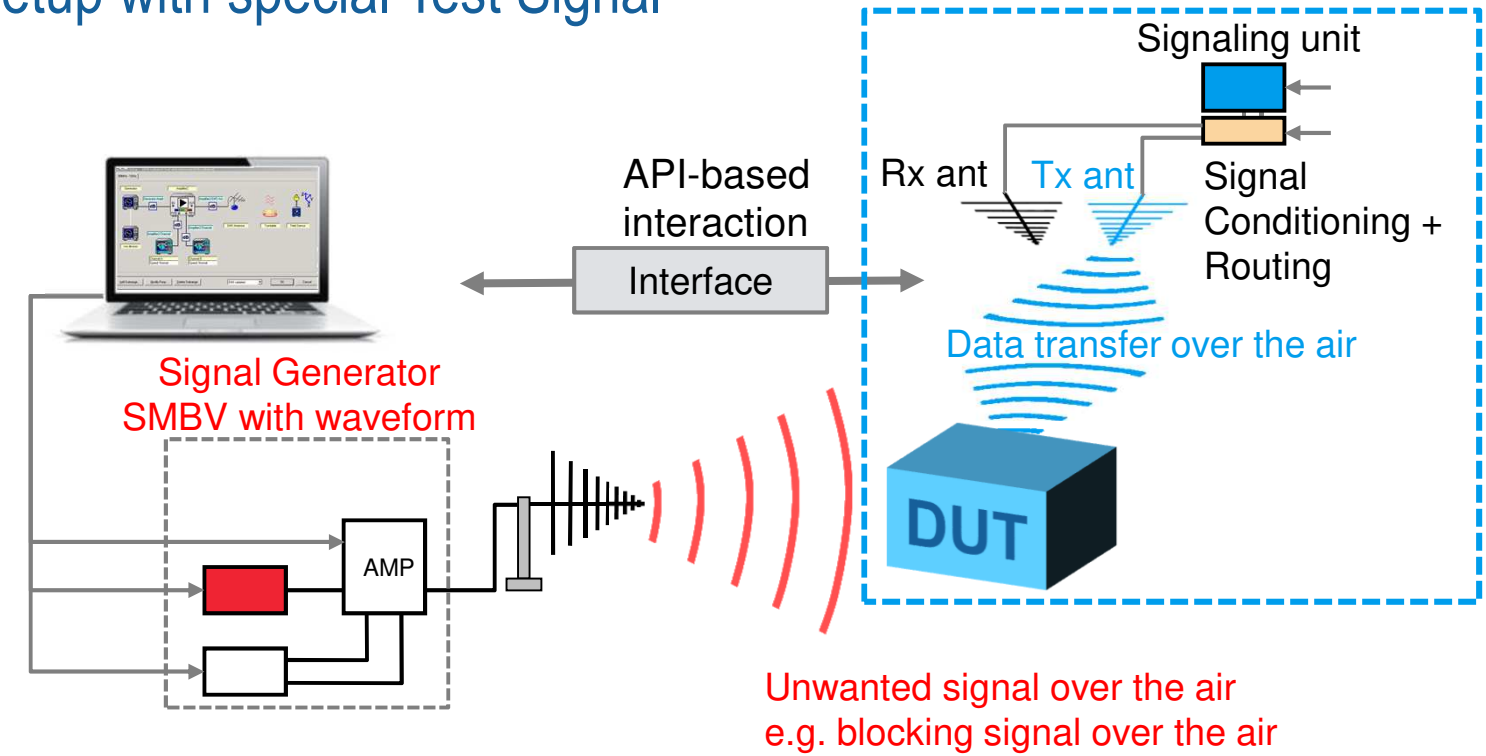
e.g. non-cellular link maintained by CMW.
Parmeter to monitor:
PER, BER or NACK

Throughput reported by the DUT can be used for the characterization of the communication quality.

Immunity Testsetup with special Test Signal



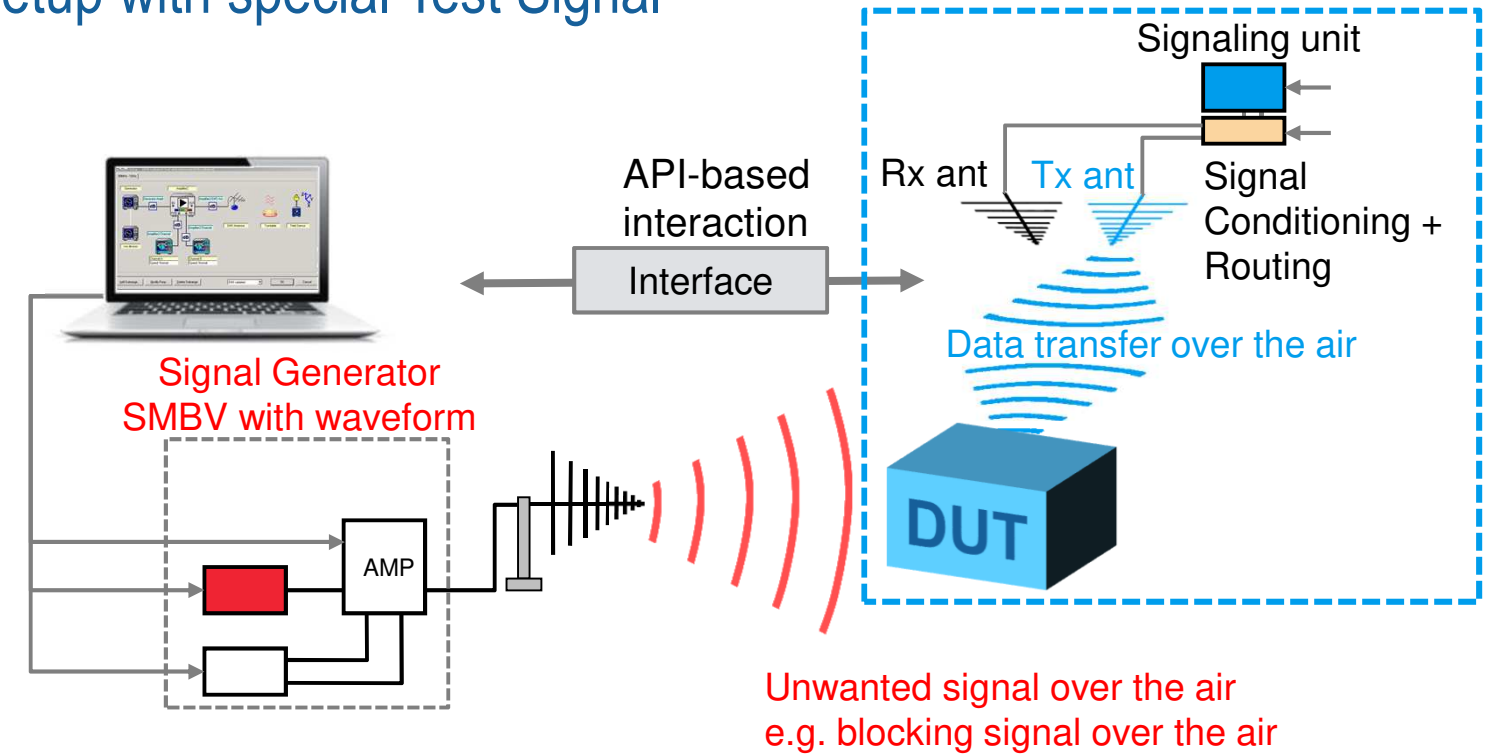
Immunity Testsetup with special Test Signal



Blocking signal provided through „immunity system“

Do you remember Audio-Break-Through Tests? Do you see the similarity?

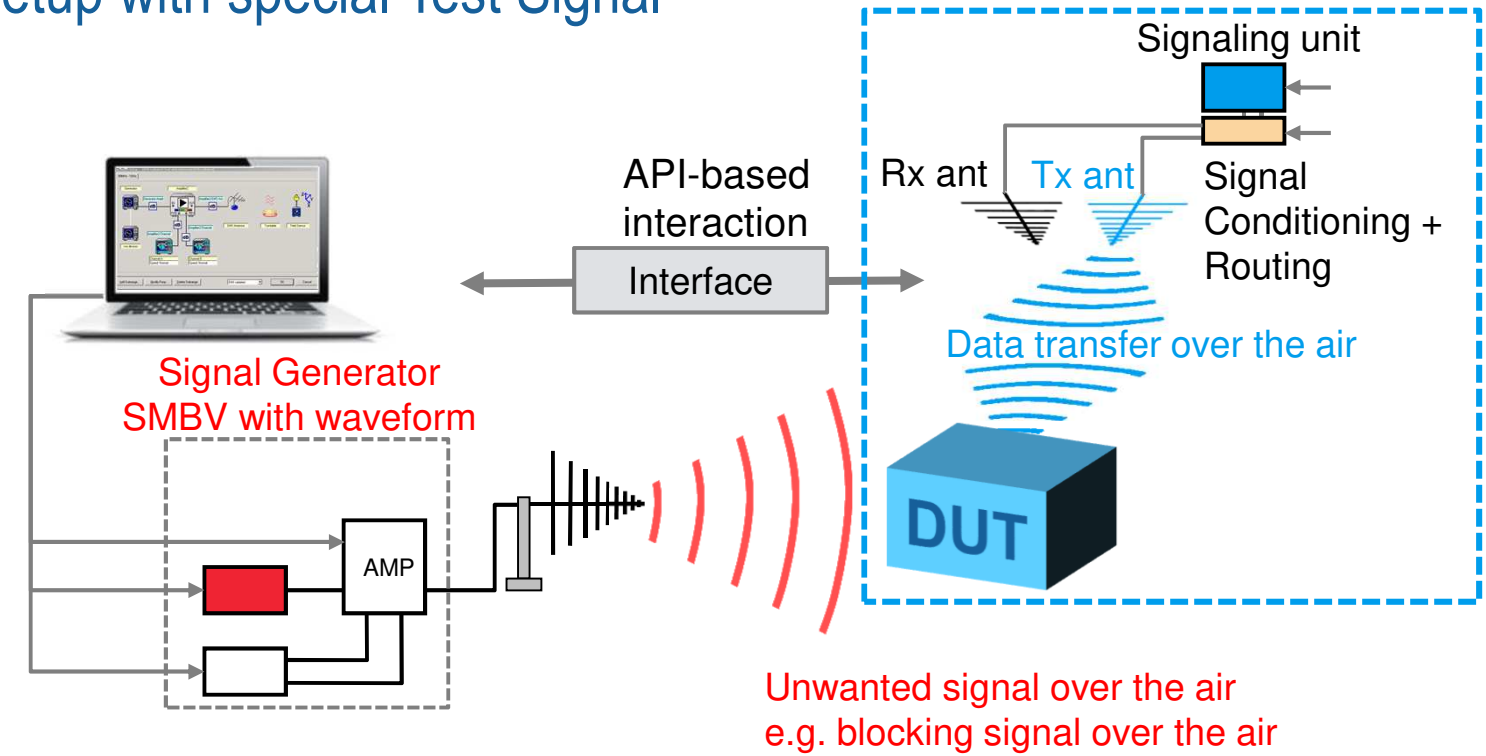
Immunity Testsetup with special Test Signal



Blocking signal provided through „immunity system“

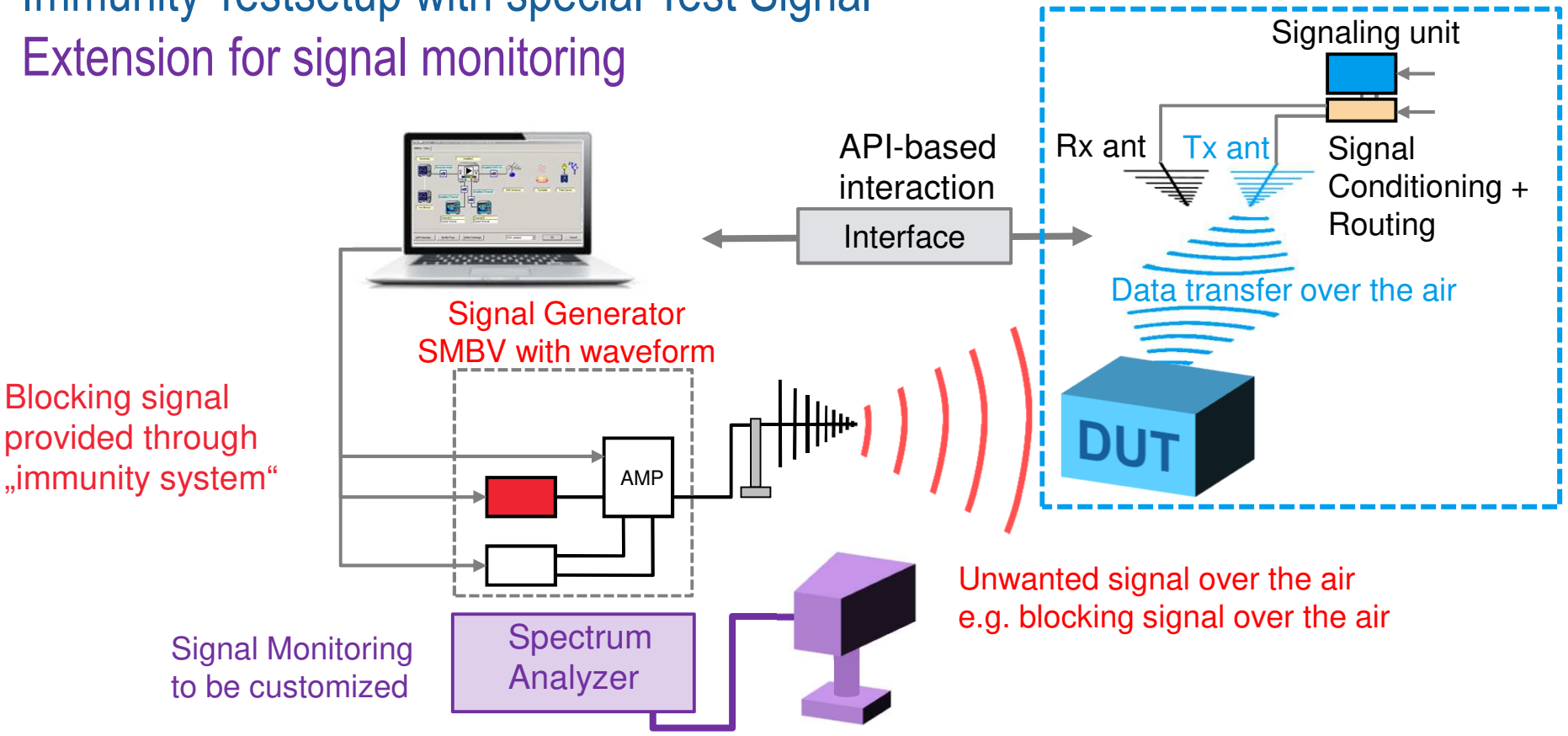
OTA specialists may recognize a sensitvity test setup for TIS in the right block.

Immunity Testsetup with special Test Signal



Immunity specialists regard the right block as a sub-system for EUT Monitoring.

Immunity Testsetup with special Test Signal
Extension for signal monitoring



Field Strength and Power Discussion

Scenario
Separation distance.
Interferer signal EIRP at origin.
Expected fieldstrength of the „unwanted signal“ at the UUT (victim).

Simulation by immunity system
Expected field strength at UUT.
Distance between UUT and antenna for the transmission of the unwanted signal. Antenna gain.

RMS power level
Calculation of the transmit power level of the unwanted signal at the antenna input.

Additional Factors
- number of subcarriers
- Bandwidth correction
  e.g. in case of transient interferers.

Crest Factor, PAPR
Typical for LTE: 8 dB

Be careful:
Most tools allow the evaluation of power and fieldstrength conditions for „RMS“.
For active RF signal paths you need to consider the Peak-to-Average Power Ratio PAPR (→Crest Factor).
Typical PAPR values can be derived from technical studies.
A PAPR of 8 dB is often used for LTE signal types.

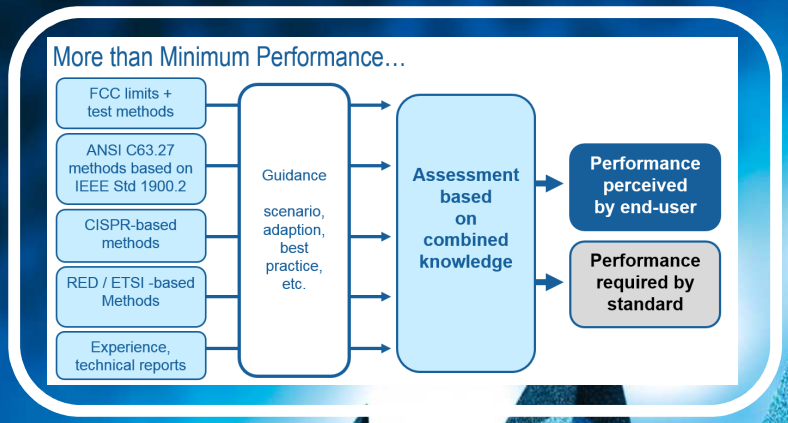
More details follow later.

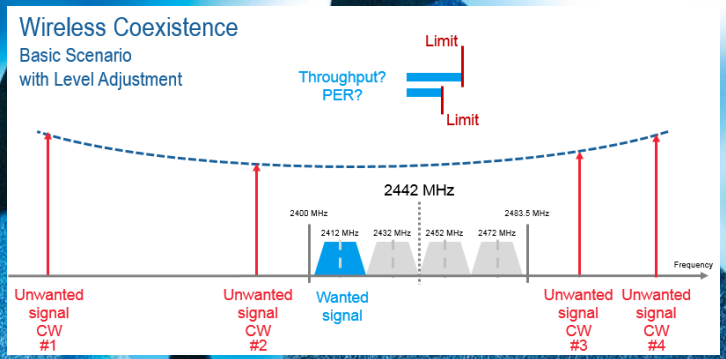
Refresher Topics on Radio Equipment Directive

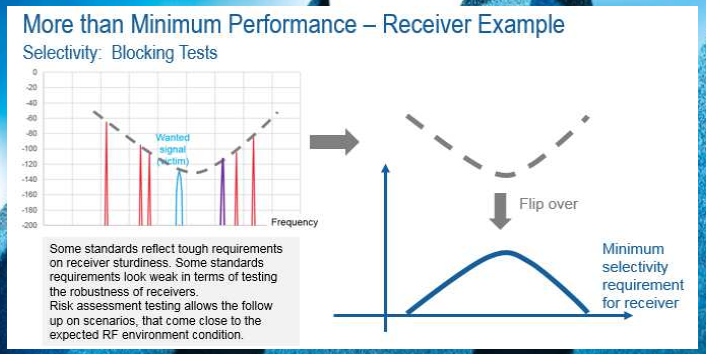
Agenda

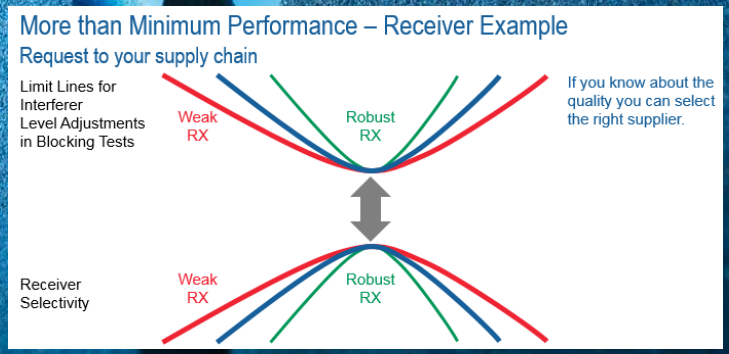
- Who cares? Administrative Part
- Increase of Testing Efforts
- Self-Declaration,
  how to find a published Harmonised Standard
- Wireless Coexistence Basics: Receiver Robustness
- More than minimum Performance
- Wireless Coexistence: Adaptivity
- Further Discussion, Backup

More than Minimum Performance

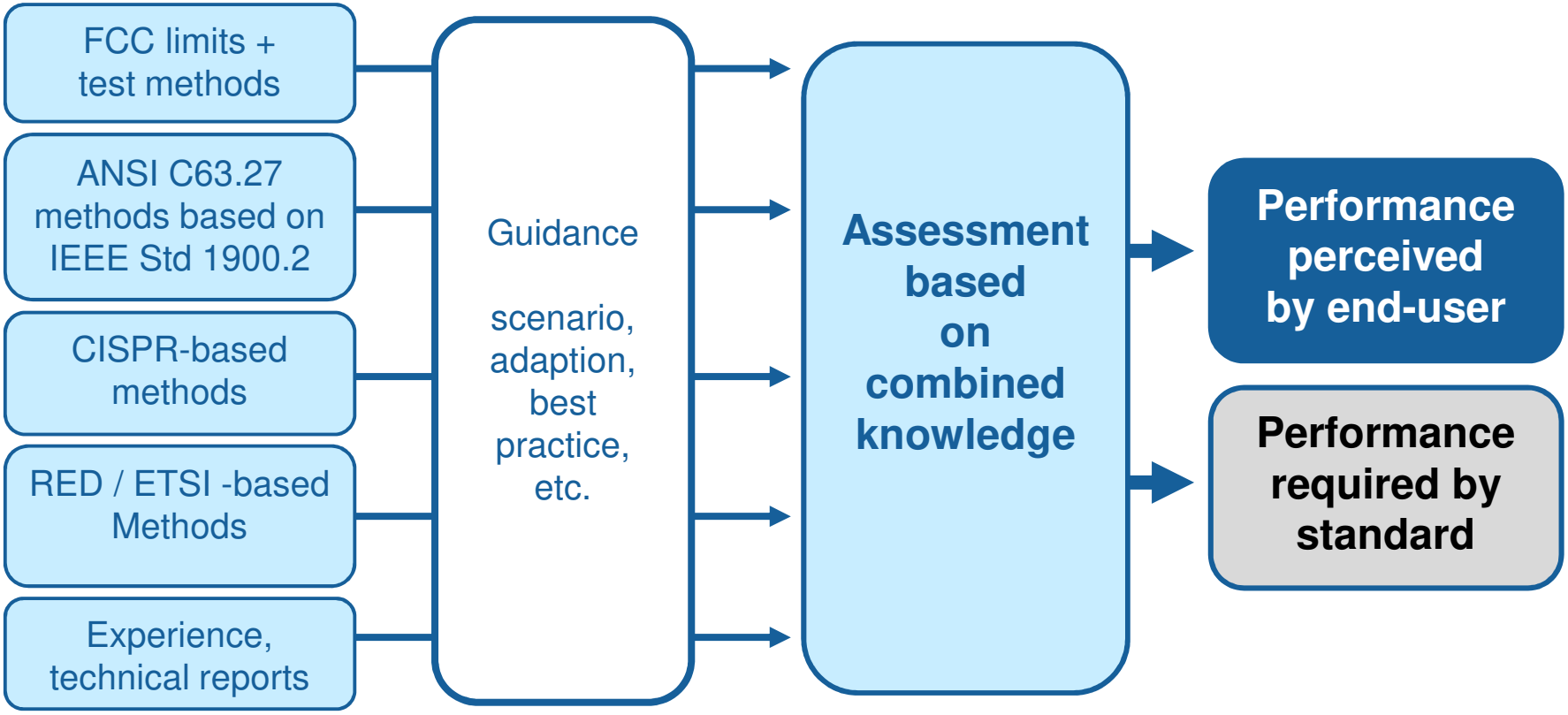




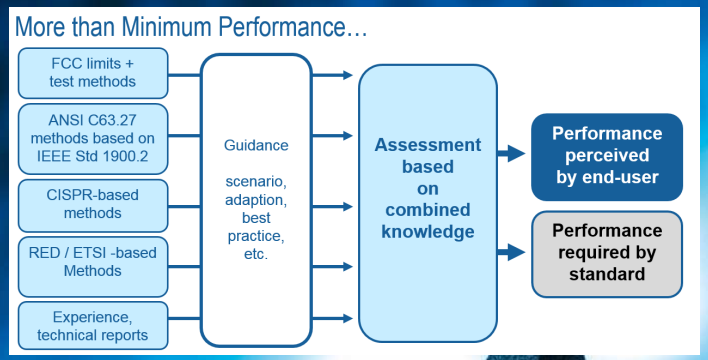


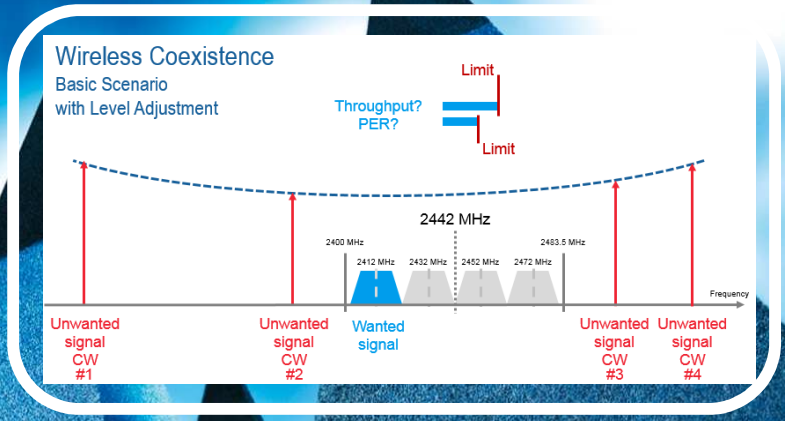


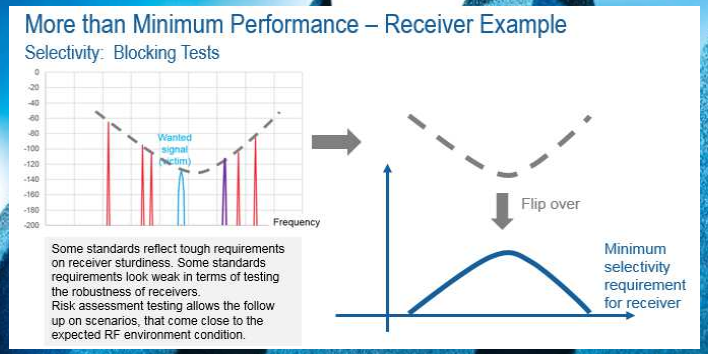
More than Minimum Performance

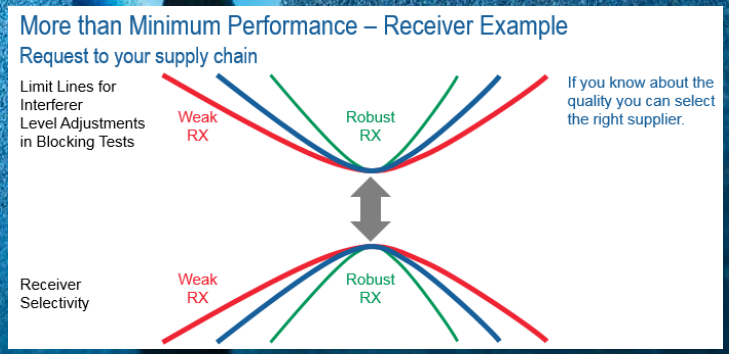


More than Minimum Performance



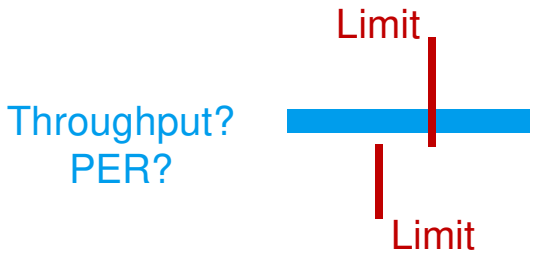


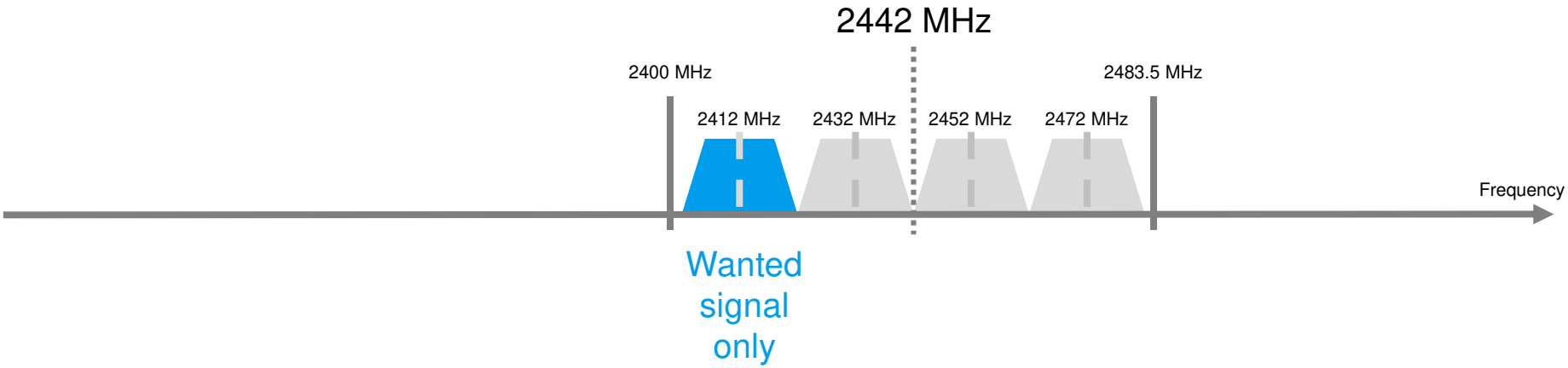




Wireless Coexistence

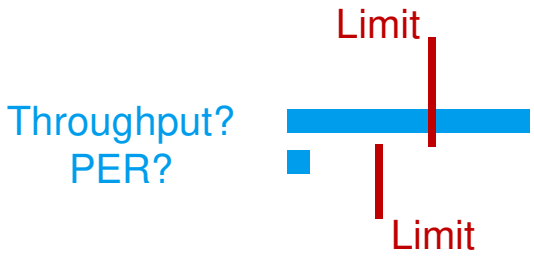
Basic Scenario
with Level Adjustment

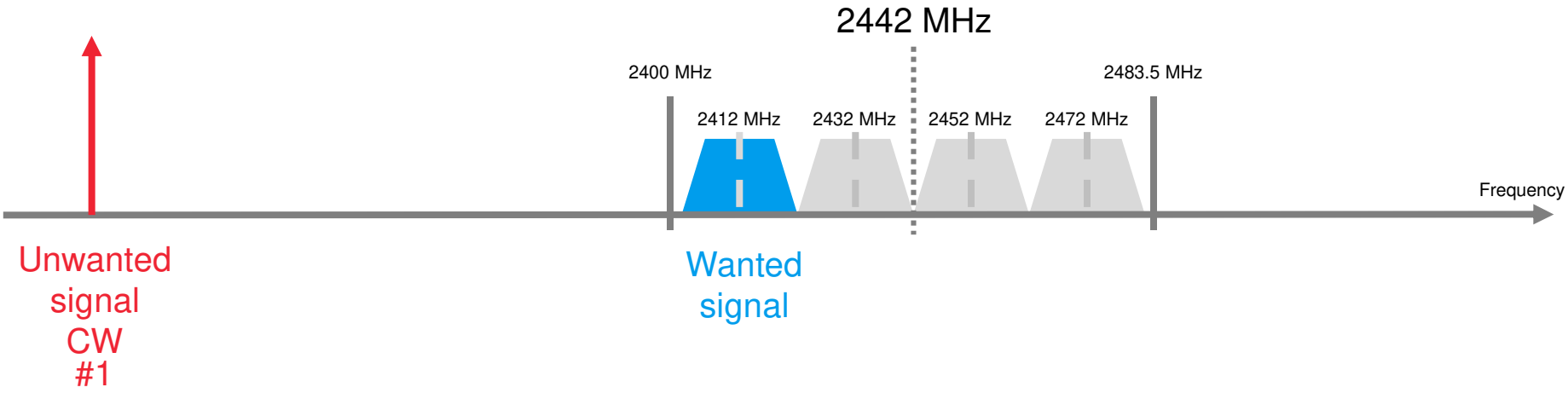




Wireless Coexistence

Basic Scenario
with Level Adjustment





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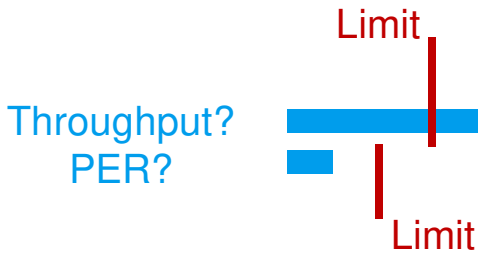
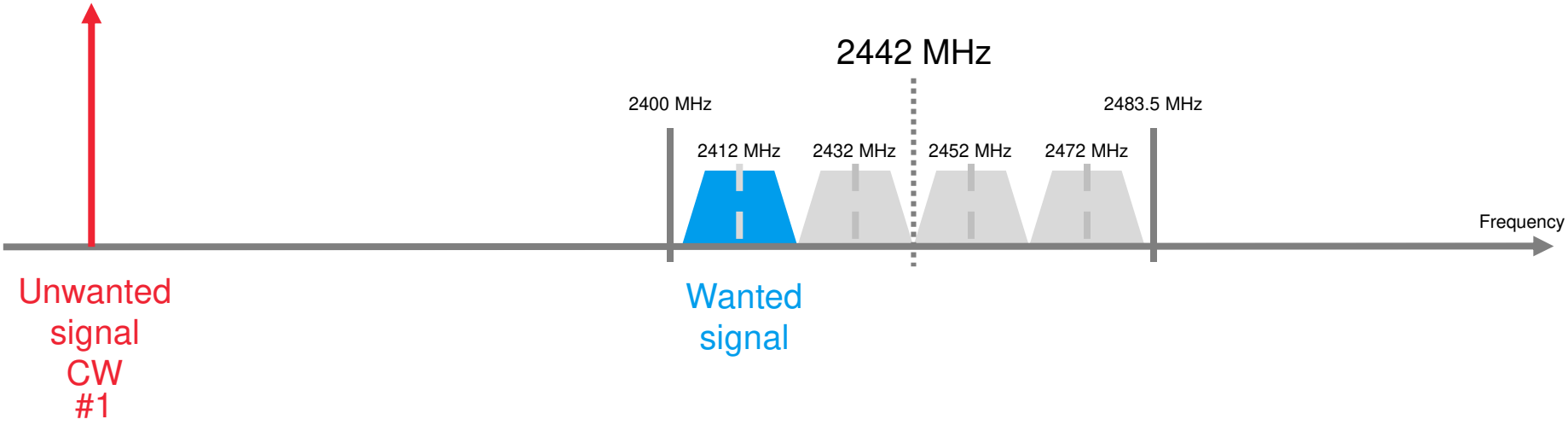
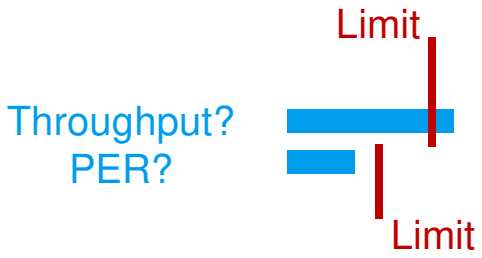
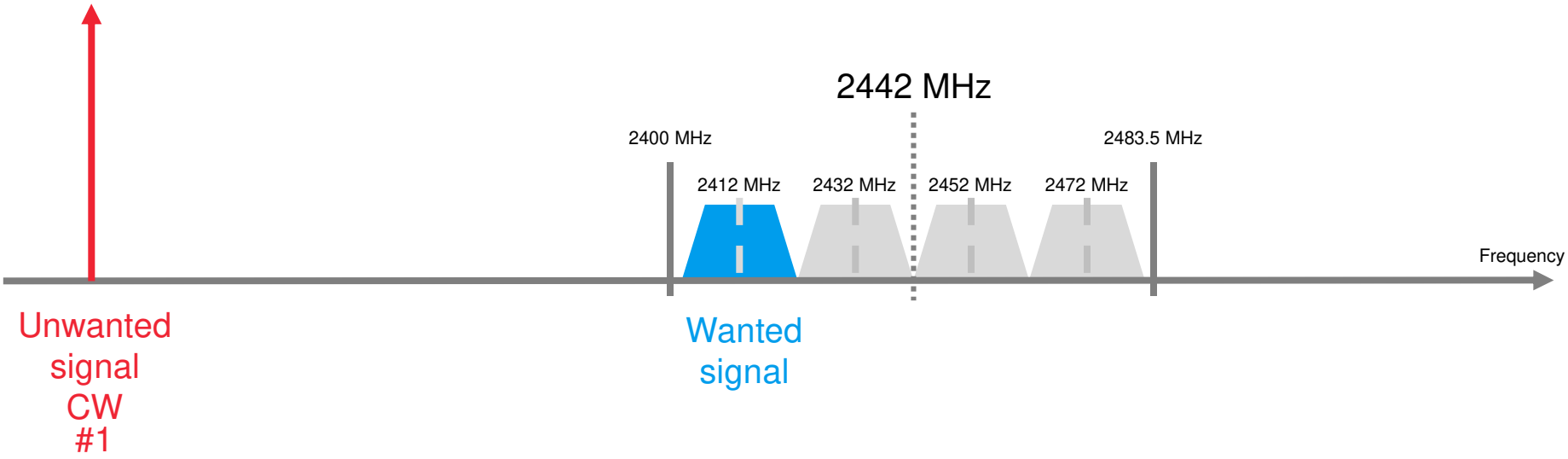




Wireless Coexistence

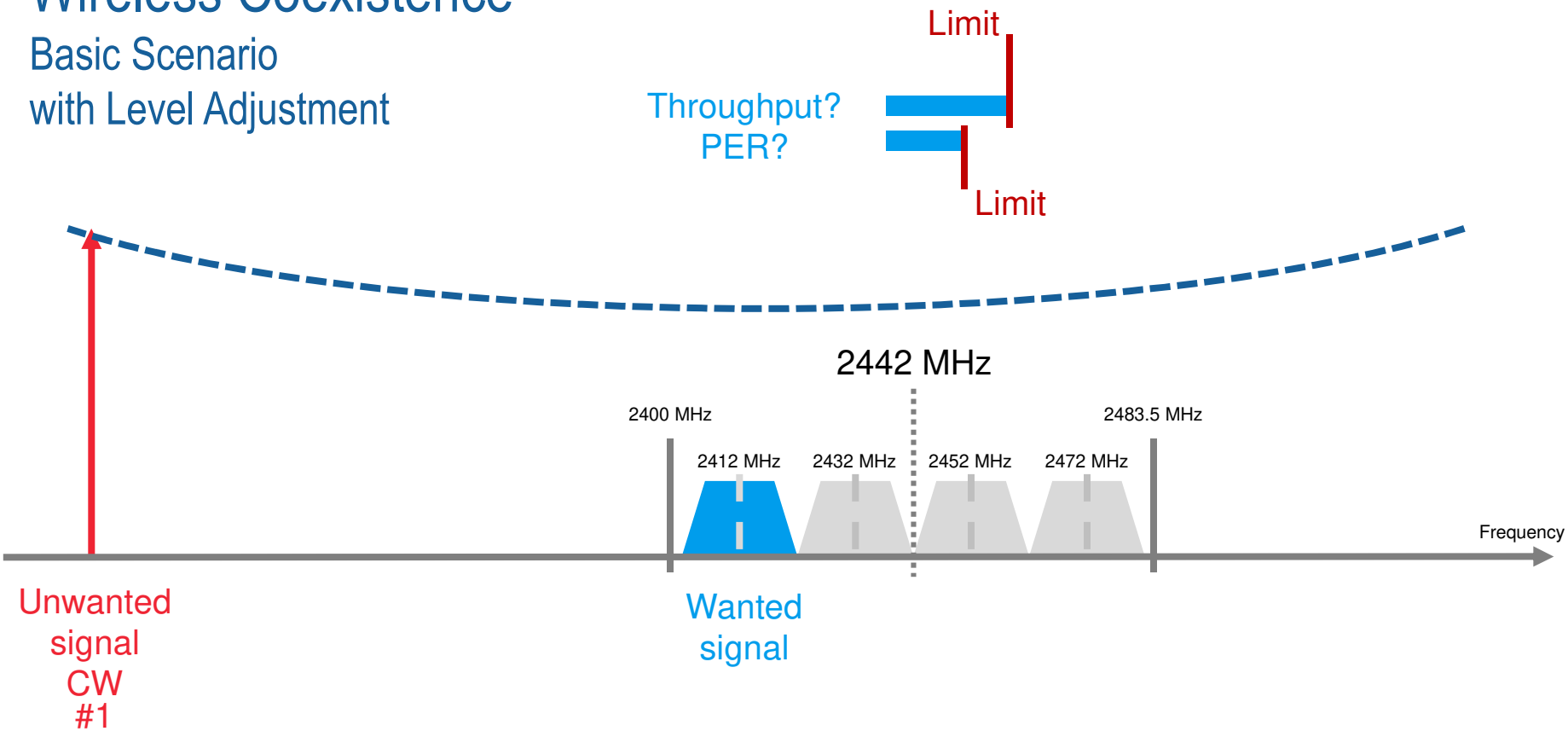
Basic Scenario
with Level Adjustment





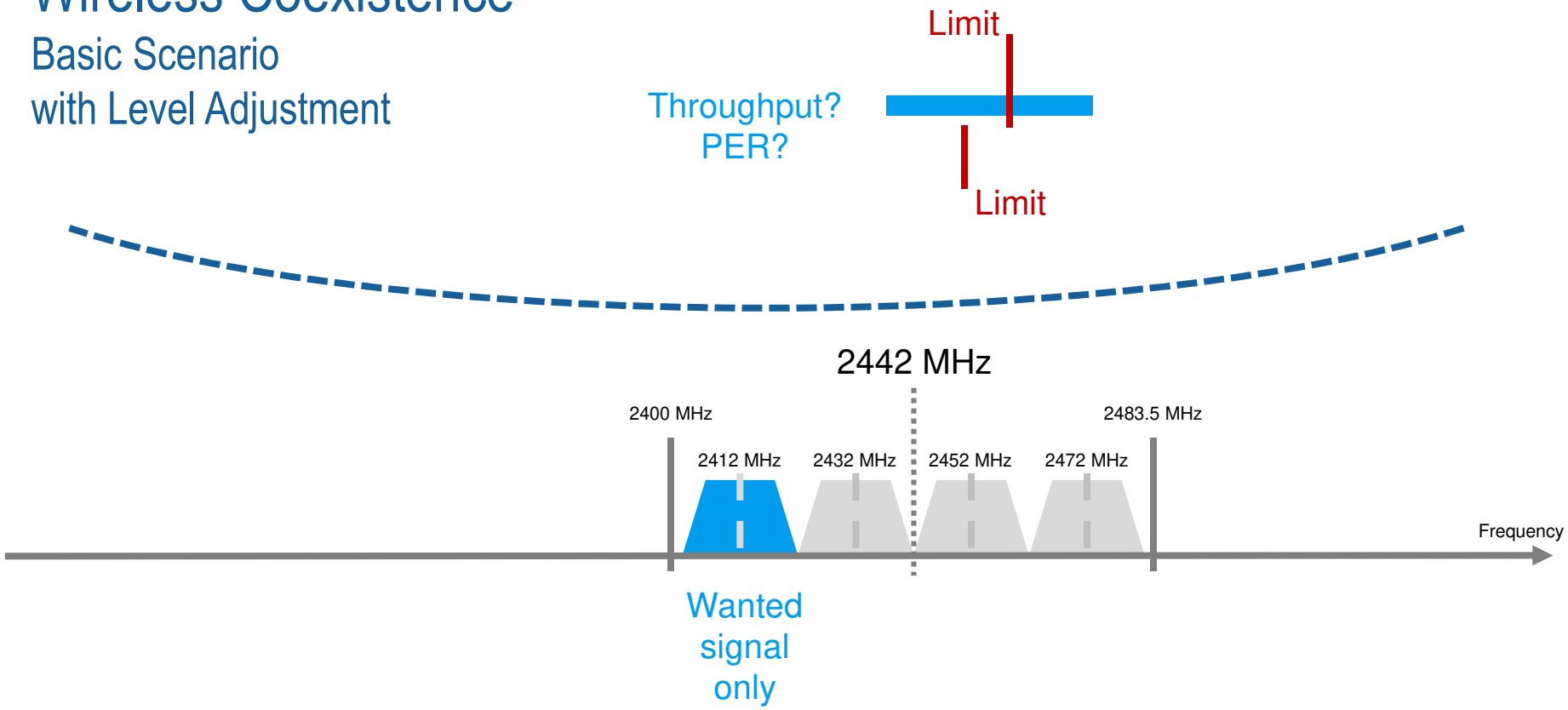
Wireless Coexistence

Basic Scenario
with Level Adjustment



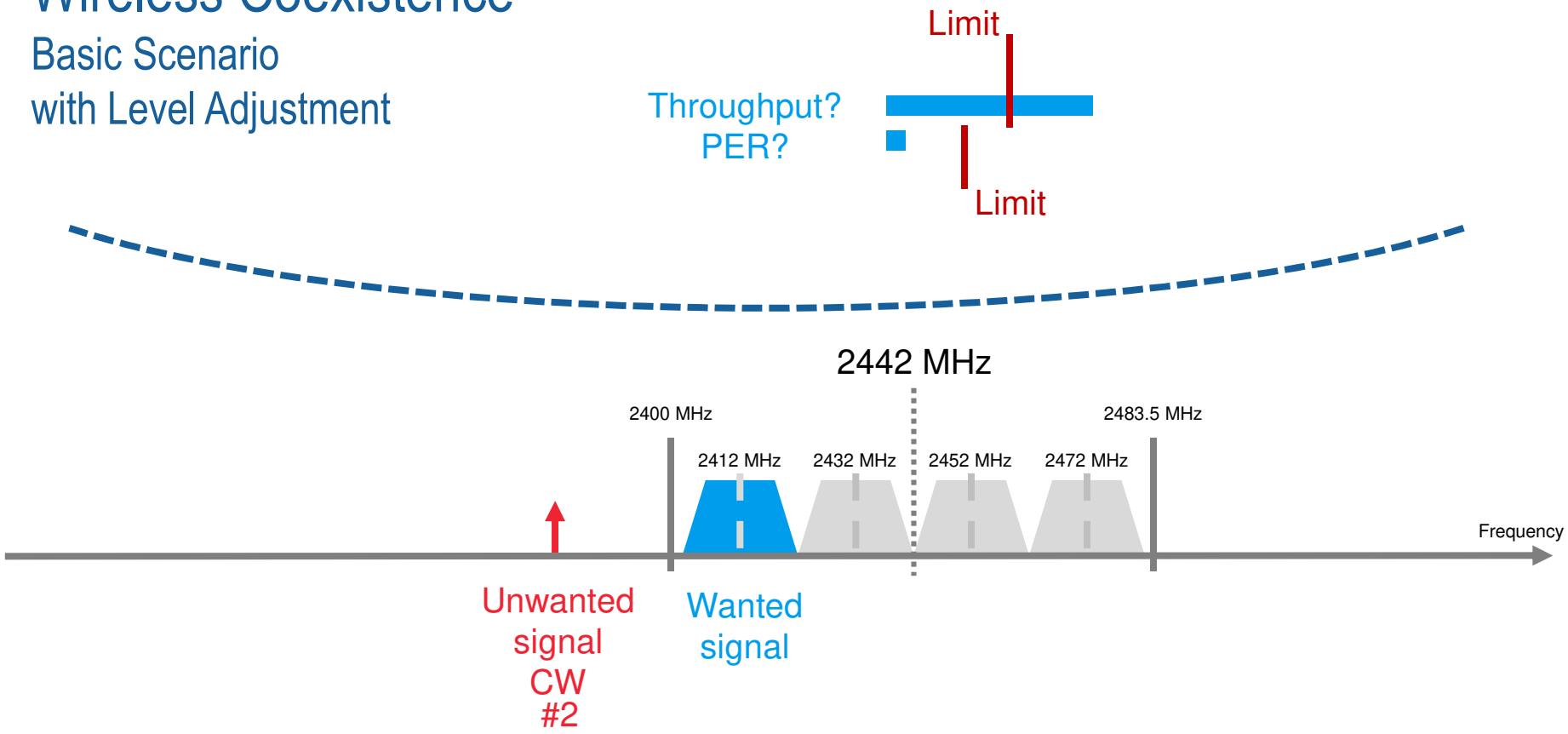
Wireless Coexistence

Basic Scenario
with Level Adjustment



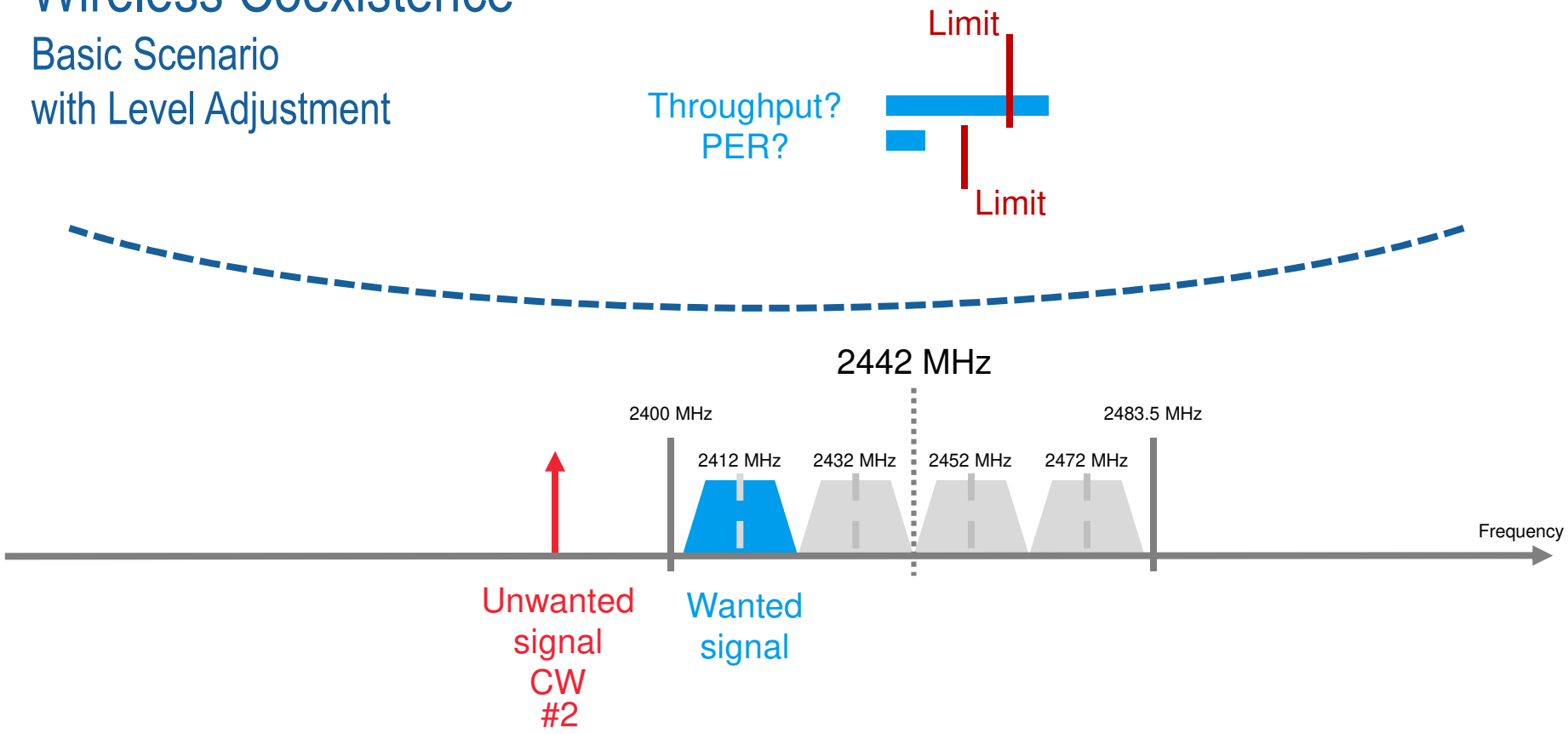
Wireless Coexistence

Basic Scenario
with Level Adjustment



Wireless Coexistence

Basic Scenario
with Level Adjustment



Wireless Coexistence

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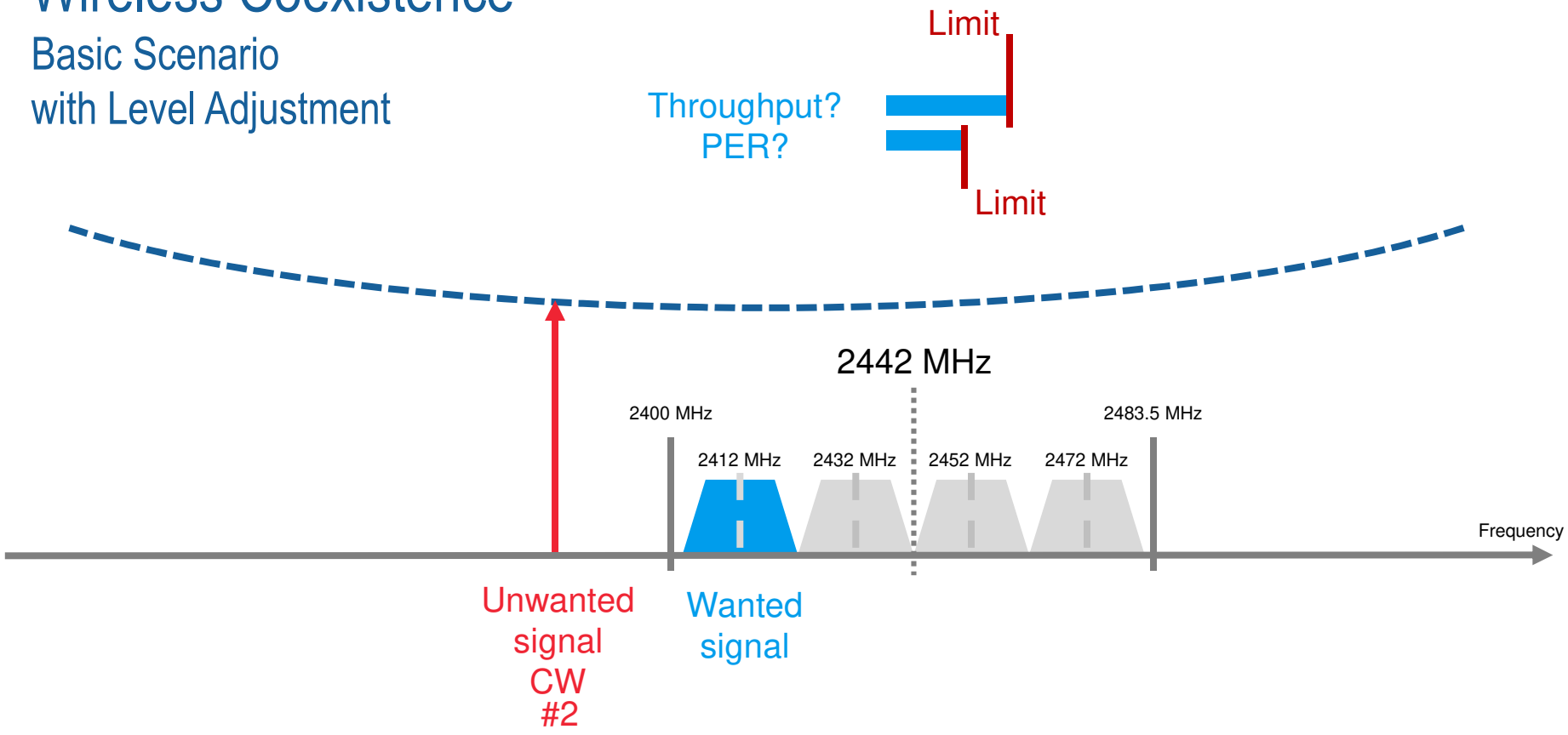

Wireless Coexistence

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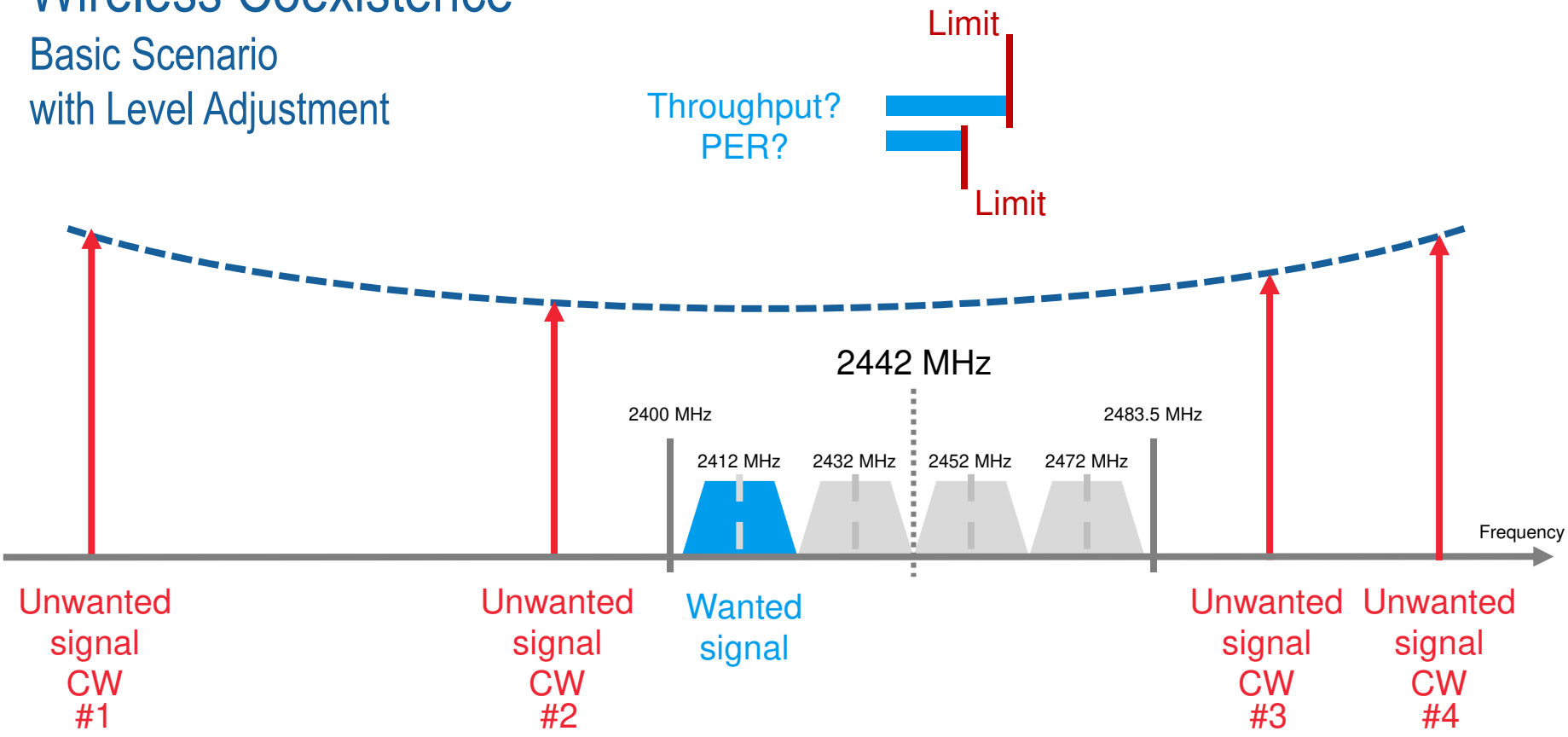
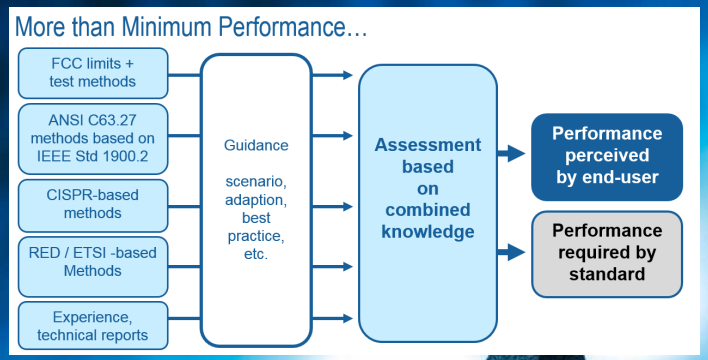
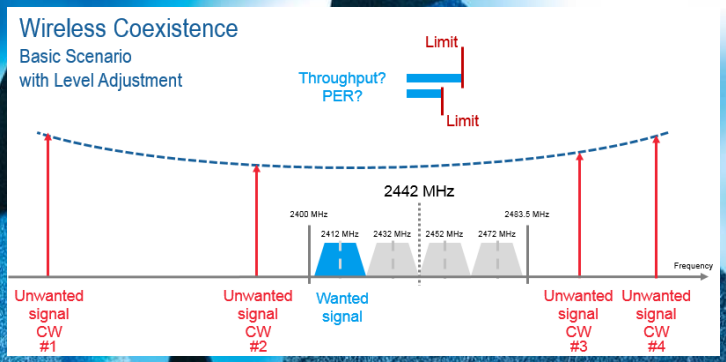
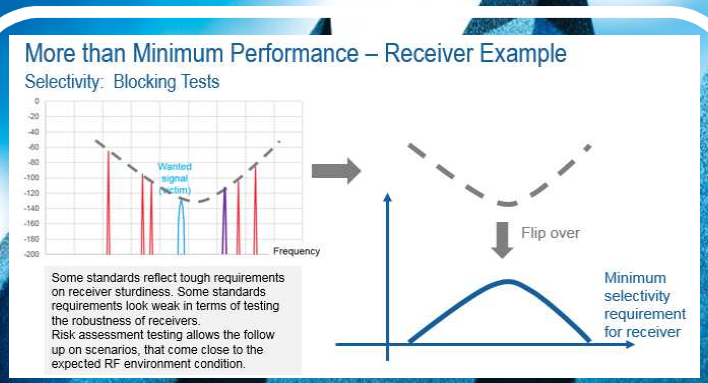
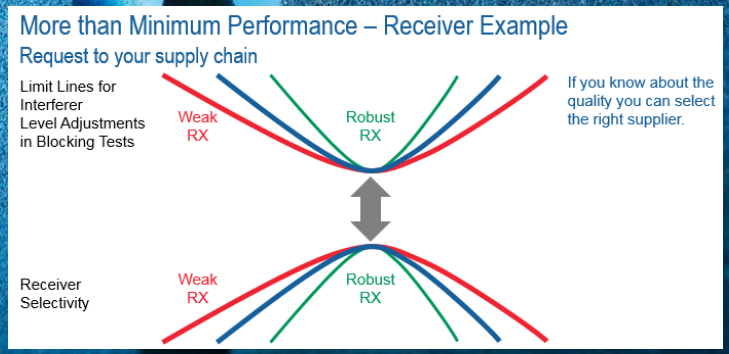


More than Minimum Performance









More than Minimum Performance – Receiver Example

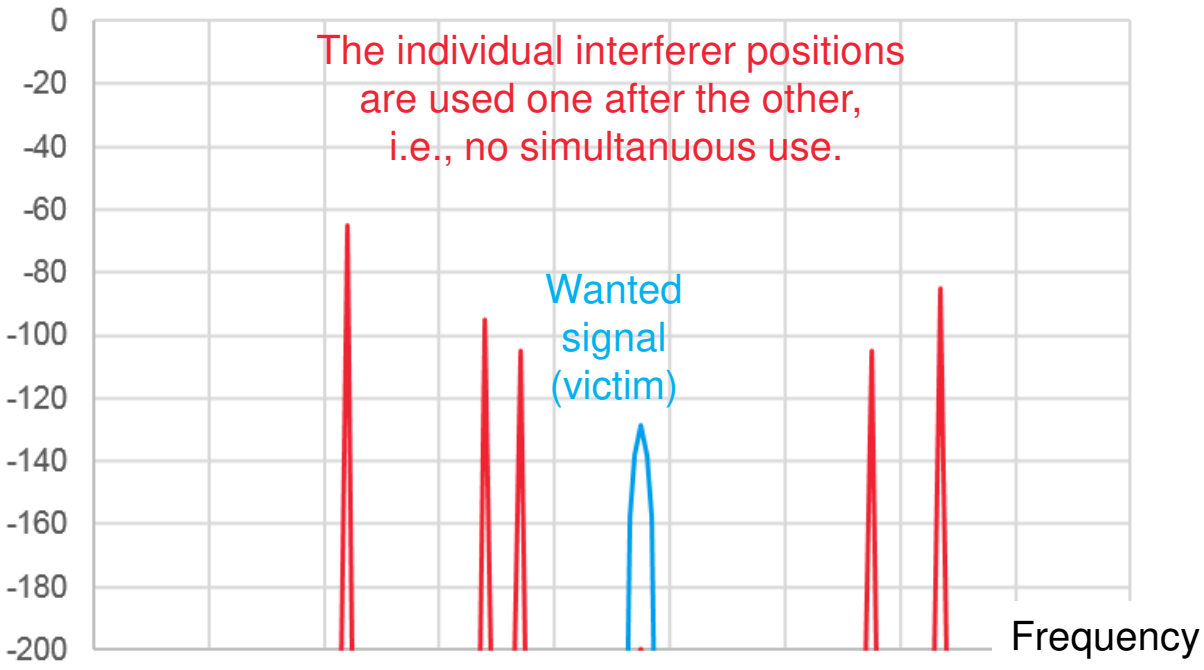
Selectivity: Blocking Tests

Signal level in dBm

Interferer Positions and Levels taken from the table(s) in the standard

One interferer per test result.

Check of receiver performance degradation.



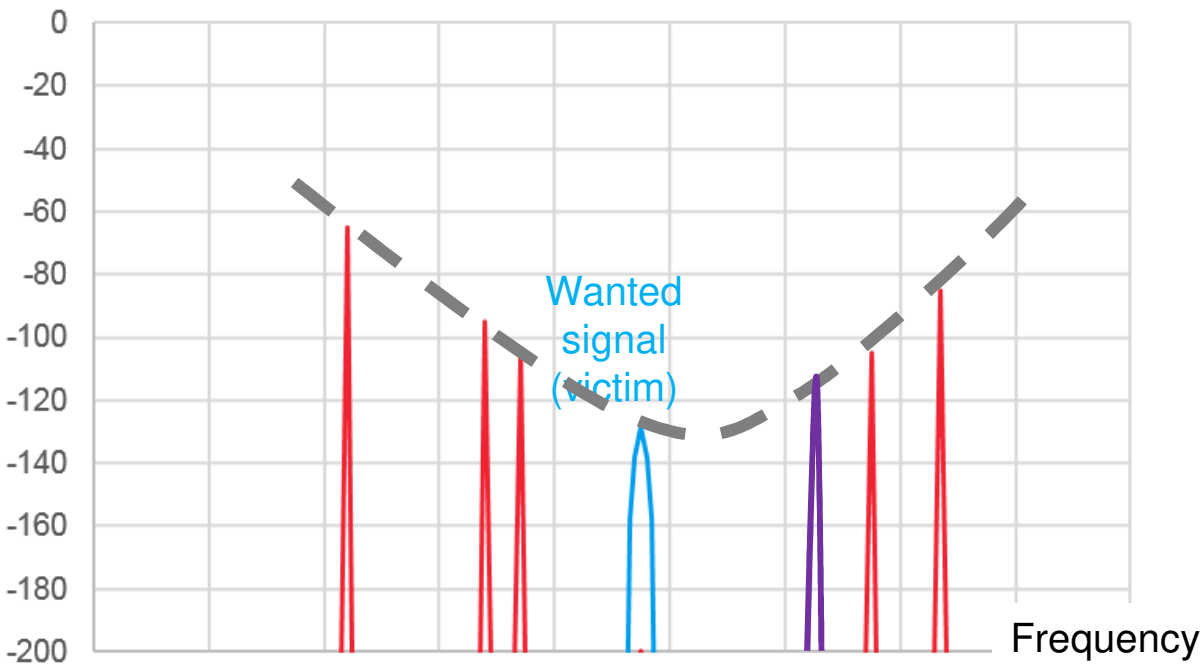
More than Minimum Performance – Receiver Example

Selectivity: Blocking Tests

Signal level in dBm

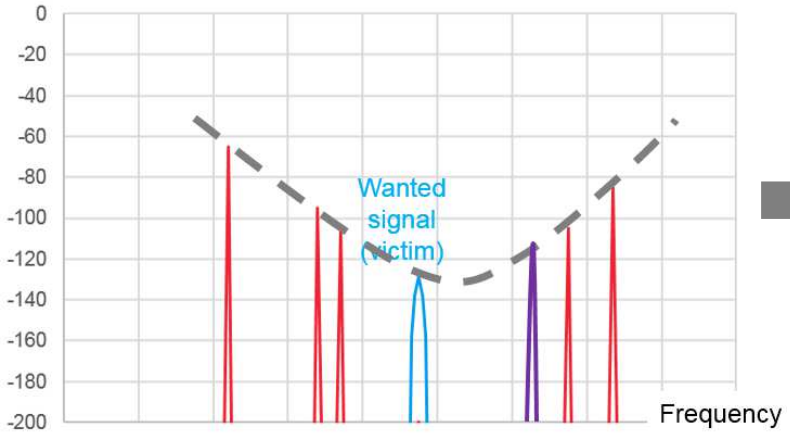
Interferer Positions and Levels taken from the table(s) in the standard

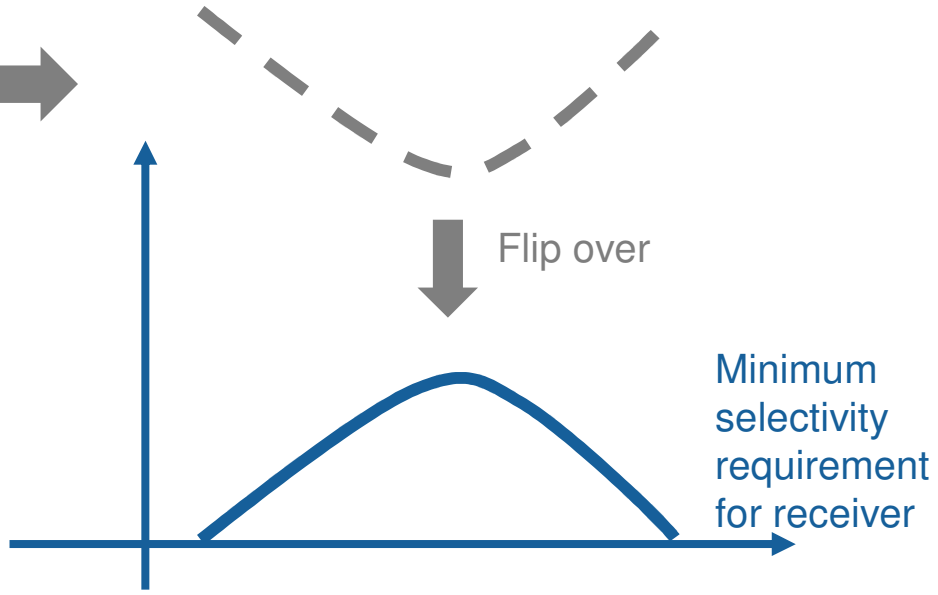
View your intra-system interferer. Does it fit into the pattern?



More than Minimum Performance – Receiver Example

Selectivity: Blocking Tests

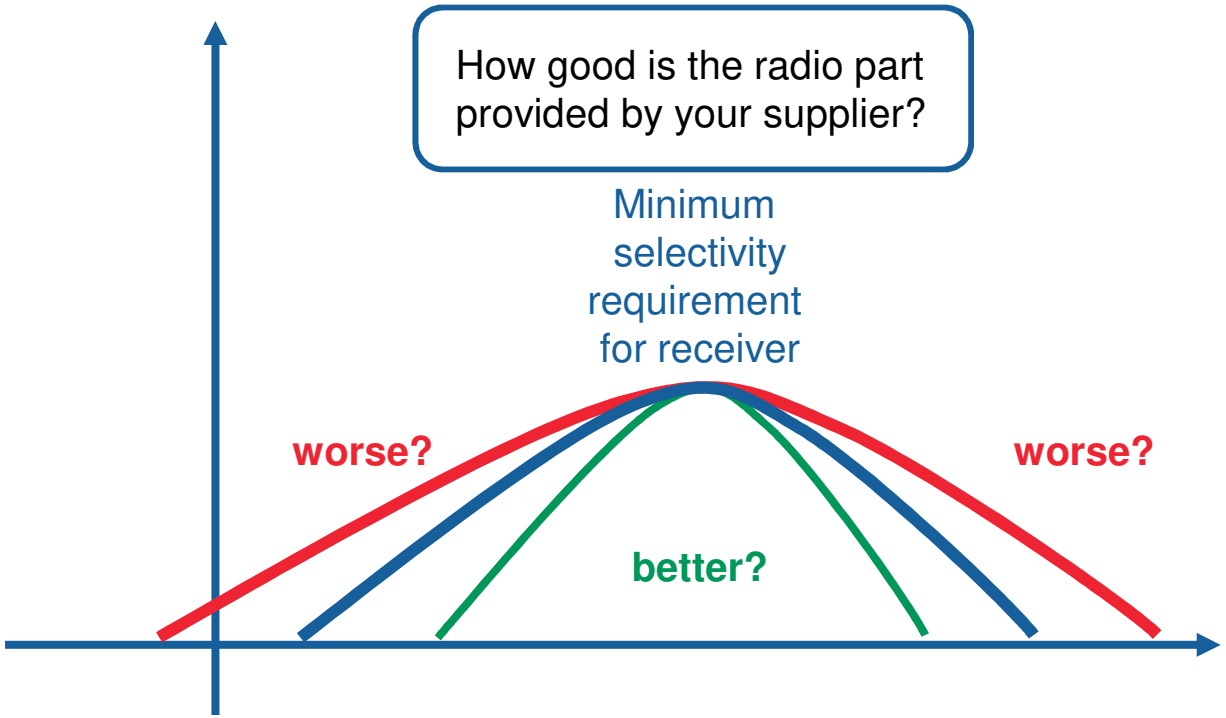




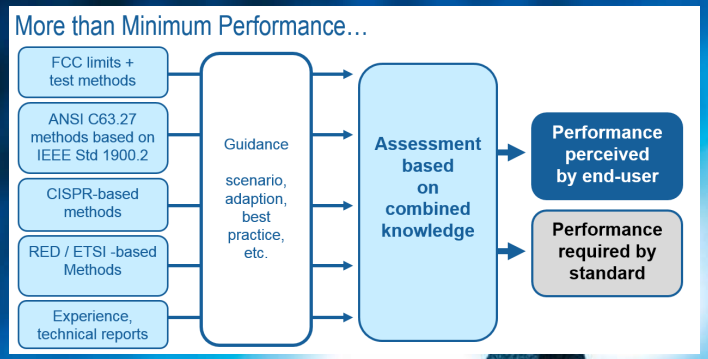
Some standards reflect tough requirements on receiver sturdiness. Some standards requirements look weak in terms of testing the robustness of receivers.
Risk assessment testing allows the follow up on scenarios, that come close to the expected RF environment condition.

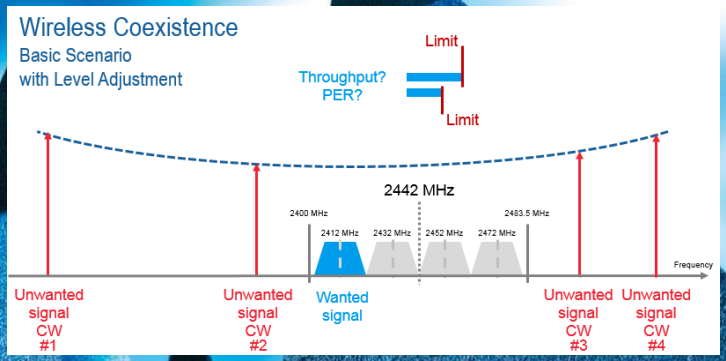
More than Minimum Performance – Receiver Example

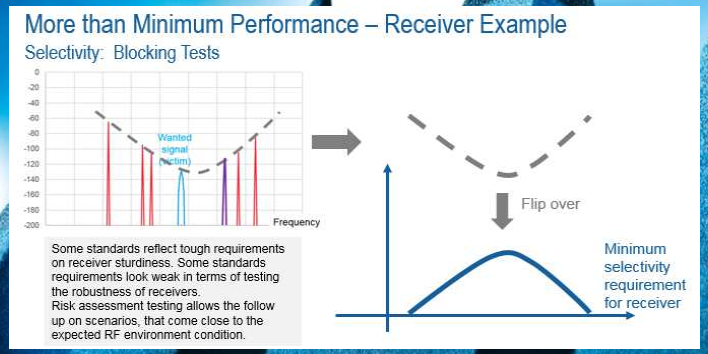
Selectivity: Blocking Tests

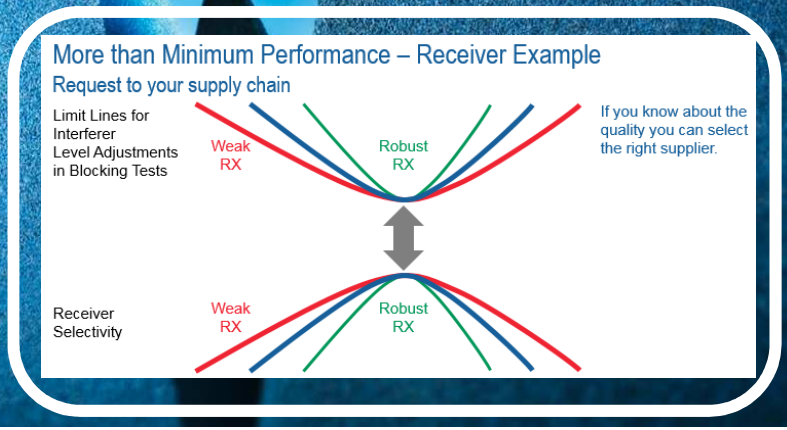


More than Minimum Performance





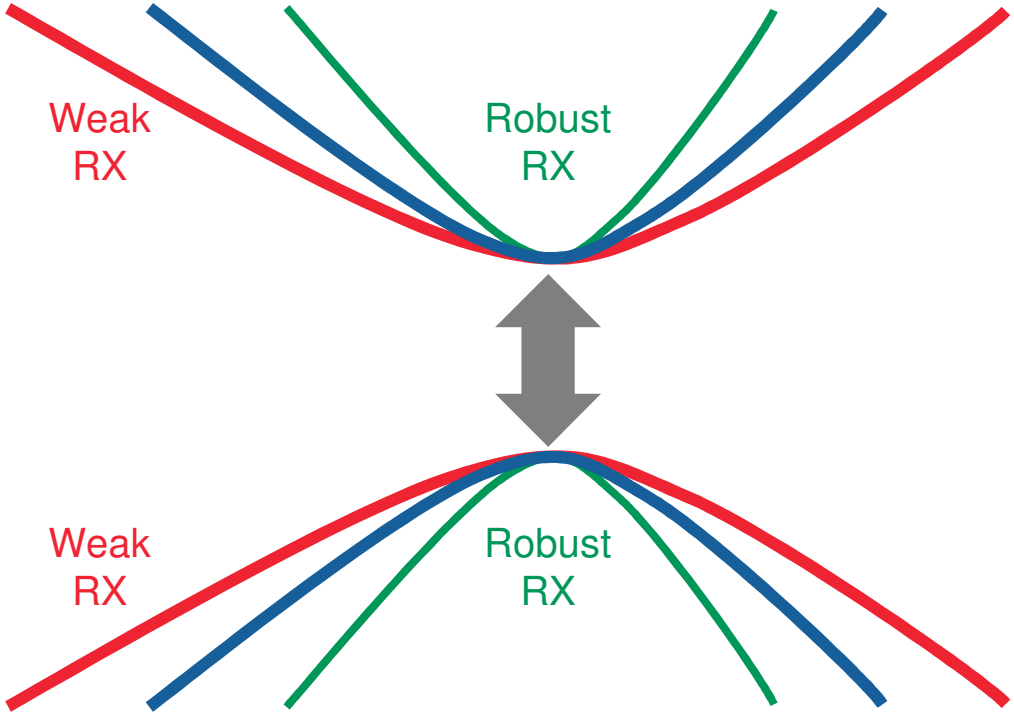




More than Minimum Performance – Receiver Example

Request to your supply chain

Limit Lines for Interferer Level Adjustments in Blocking Tests



Receiver Selectivity

If you know about the quality you can select the right supplier.

Refresher Topics on Radio Equipment Directive

Agenda

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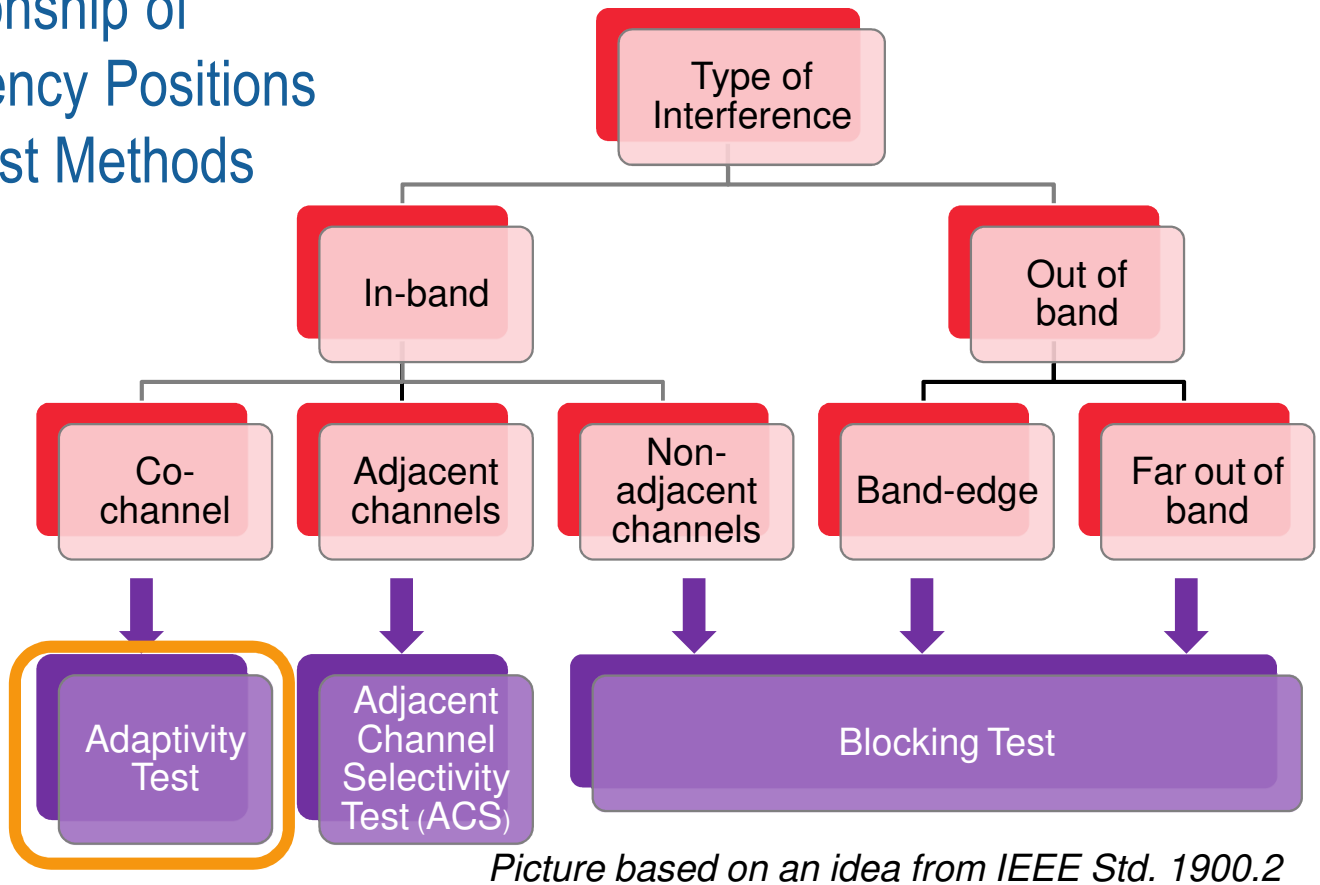
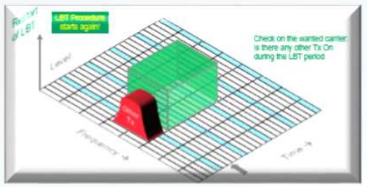
Relationship of Frequency Positions and Test Methods



Picture based on an idea from IEEE Std. 1900.2

Scenario Selection

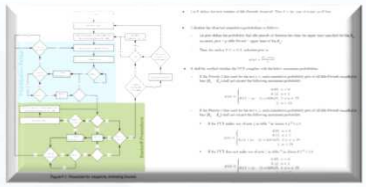
Duty Cycle
(pg.3)



Listen Before Talk
Scenario
(pg.10)

Listen Before Talk
Scenario Discussion
(pg. 31)

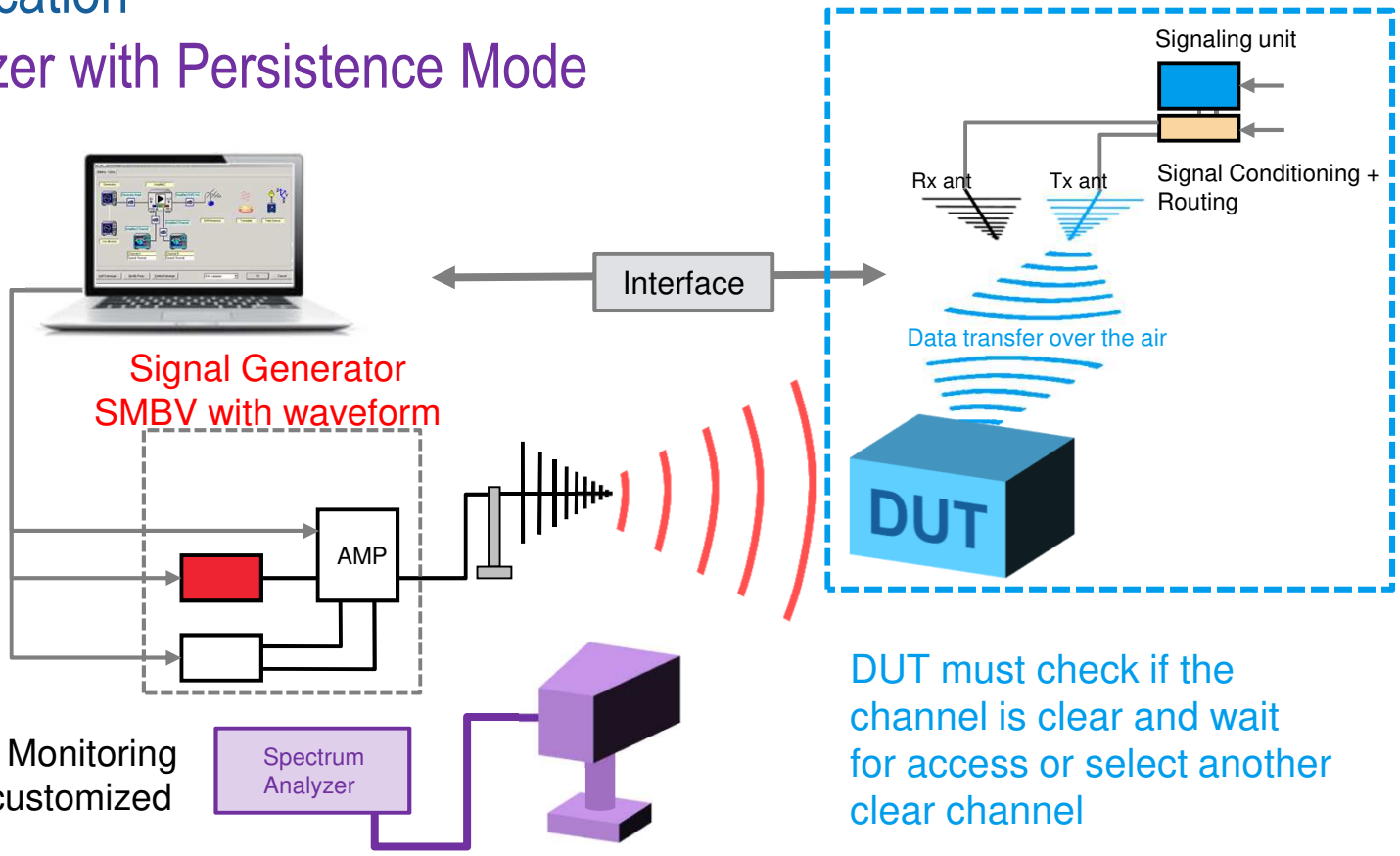
Listen Before Talk
Blocking
Scenario
(pg.37)



Channel Access
Mechanism
(pg.41)

External Slides

Adaptivity Verification
Realtime Analyzer with Persistence Mode



Co-channel signal occupies the wanted channel

Signal Monitoring to be customized

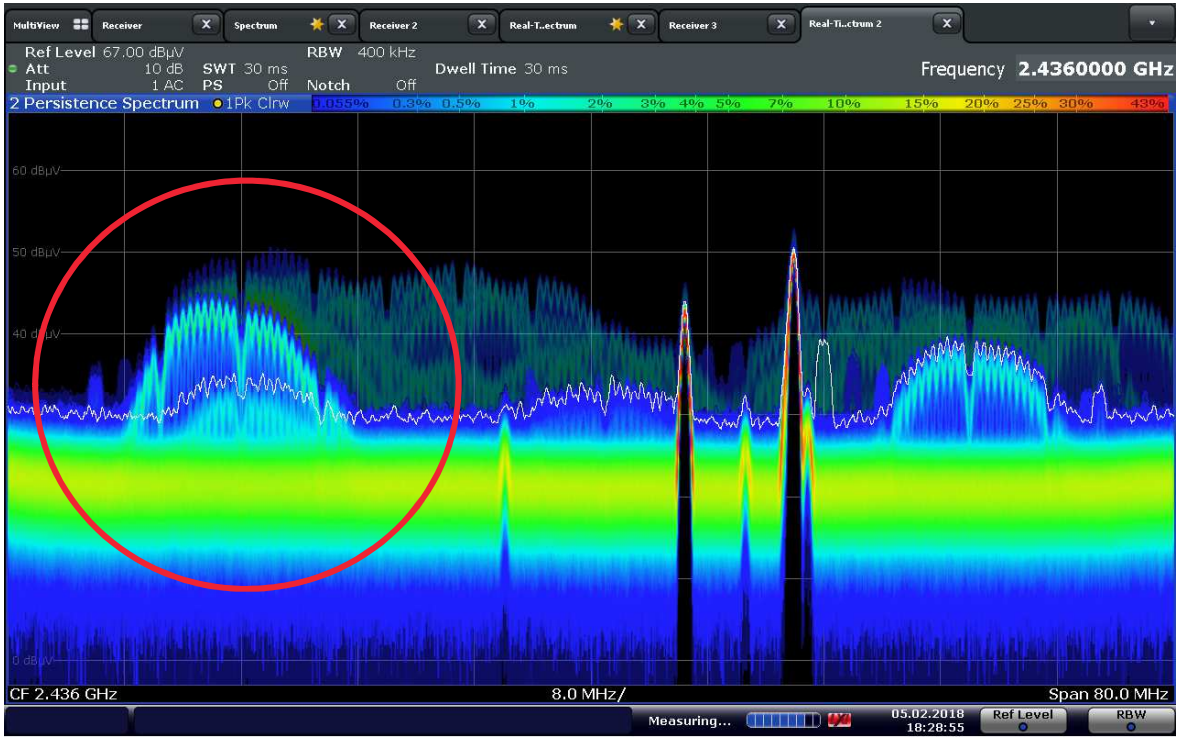
DUT must check if the channel is clear and wait for access or select another clear channel

Realtime to verify Channel Occupation / Verification

2 signals share the same channel.

Addtional spectrogram would be helpful find out the time gap between the 2 signals.

ESR, ESW or FSW with realtime option could provide with „persistence mode“ and with „spectrogram mode“. Parameters vary due to exact technical configuration.

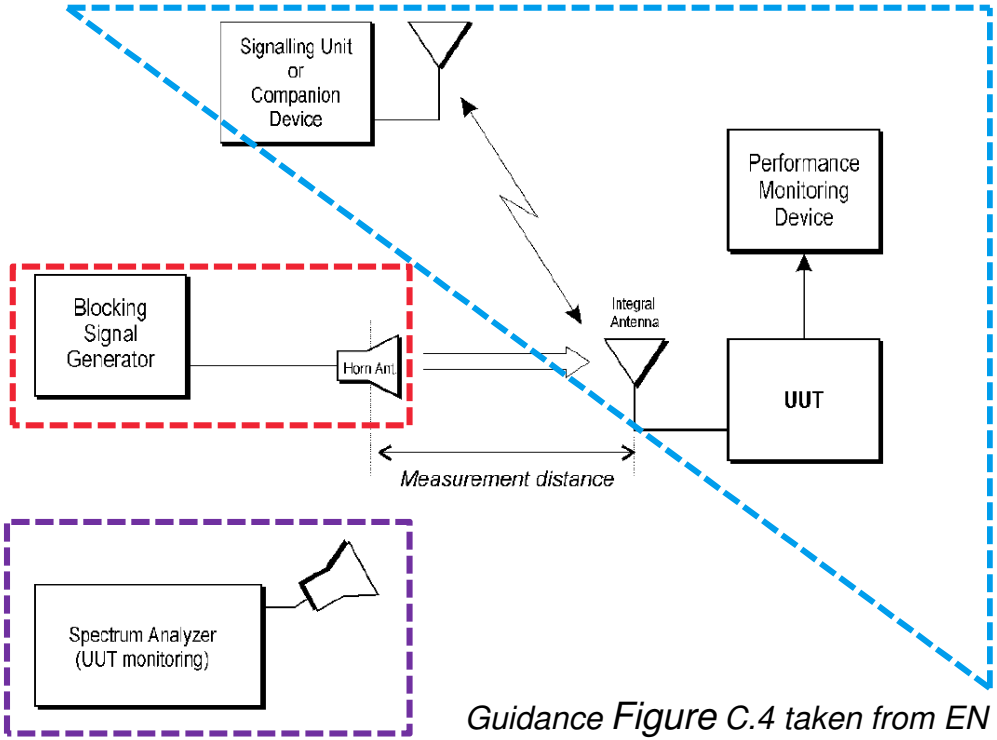


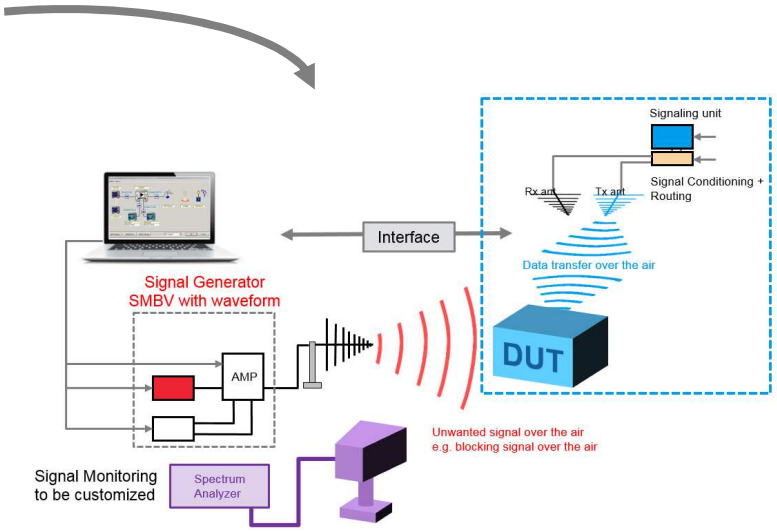
18:28:55 05.02.2018

C.5.3 Guidance for testing Receiver Blocking

C.5.3.2 Measurement Set-up, Figure C.4

„from the standard to the setup“





Guidance Figure C.4 taken from EN 301 893 v 2.1.1

Refresher Topics on Radio Equipment Directive

Agenda

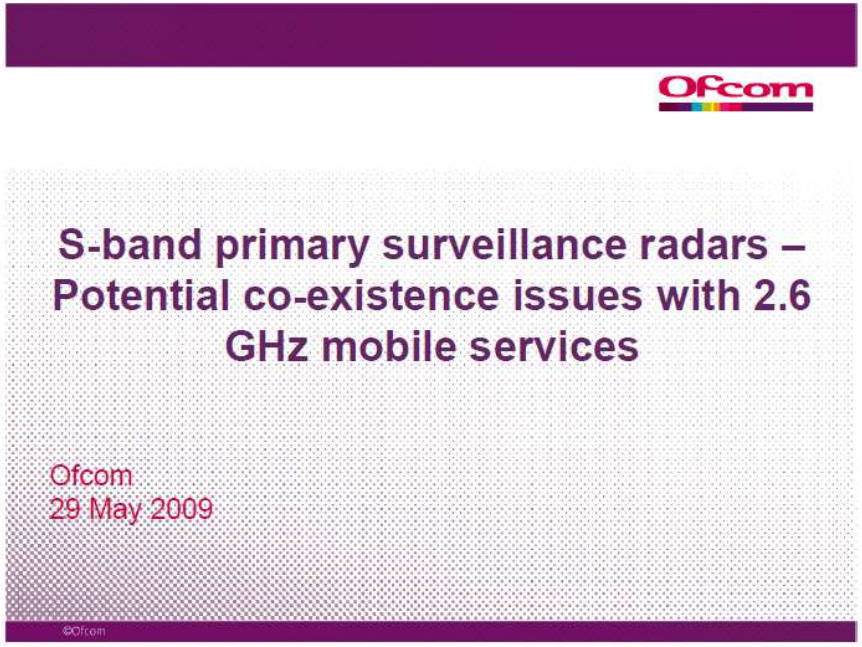
- Who cares? Administrative Part
- Increase of Testing Efforts
- Self-Declaration,
  how to find a published Harmonised Standard
- Wireless Coexistence Basics: Receiver Robustness
- More than minimum Performance
- Wireless Coexistence: Adaptivity
- Further Discussion, Backup

4 Prominent Coexistence Cases

Coexistence Case #1: LTE FDD7 vs. ATC Radar
Coexistence Case #2: LTE vs. DVB-T: Protection Ratio
Coexistence Case #3: LightSquared Case (LTE 1552.5 vs. GPSL1)
Coexistence Case #4: Co-Location under FCC

Cases #1, #2 and #3 address the need for blocking tests.
Case #4 deals with the intermodulation effect.

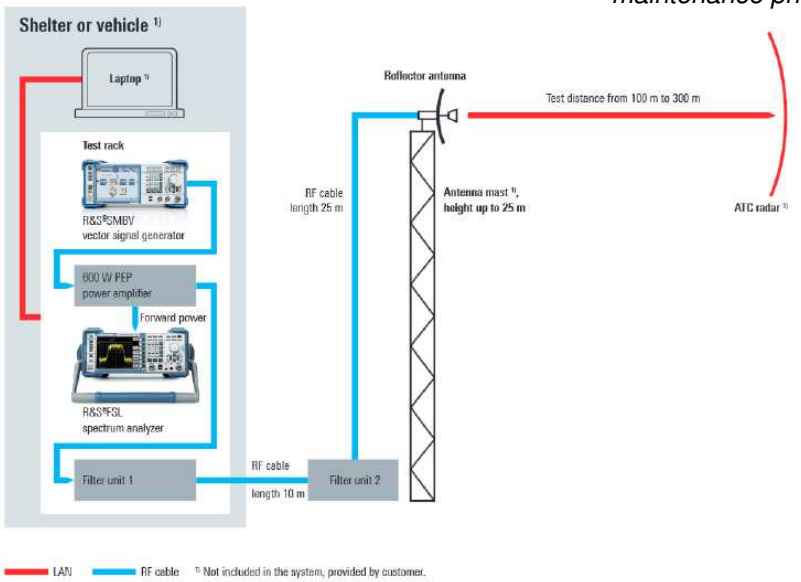
Coexistence Case #1:
LTE FDD7 vs. ATC Radar



Theory 2009

System discussion from 2011.

ATC Radar in maintenance phase



Test System TS6650.
See application note
1MA211_0e_Coexistence_Test_of_LTE_and_Radar.pdf

Practice 2011 + 2012

Coexistence Case #1:
LTE FDD7 vs. ATC Radar

See application note:
1MA211_0e_Coexistence_Test_of_LTE_and_Radar.pdf

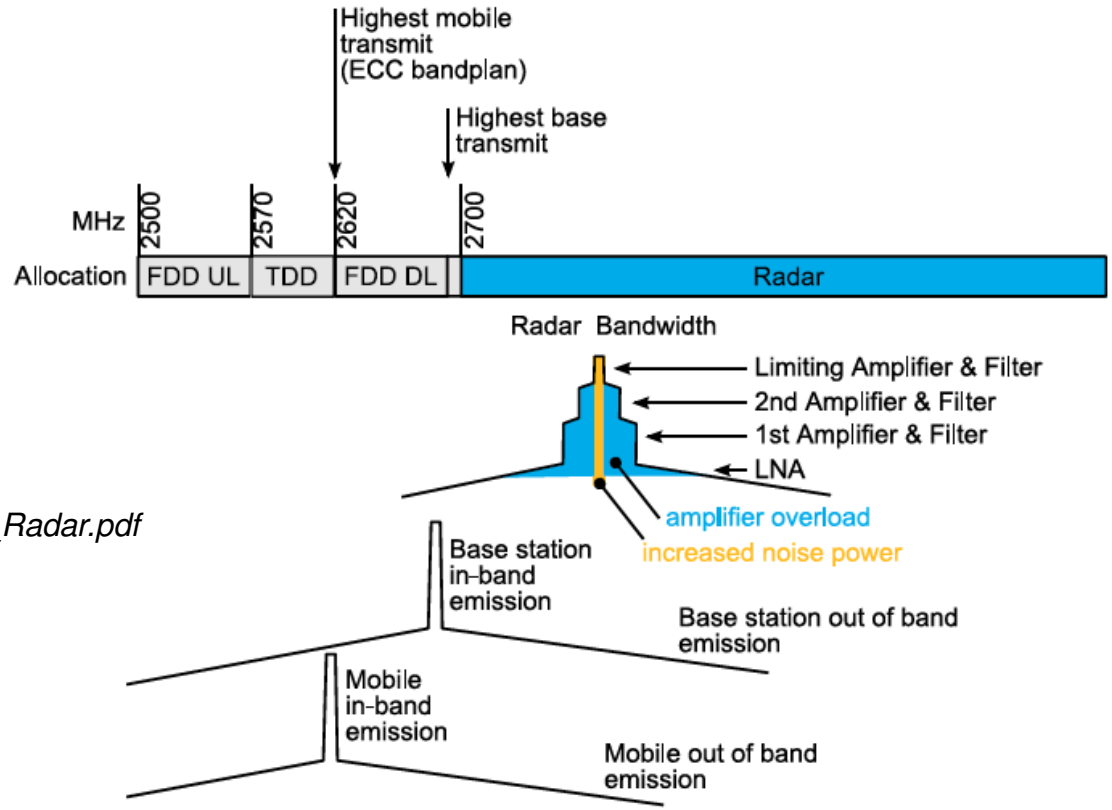


Figure 2-2: Radar Amplifier Chain in the Frequency Domain and Out-Of-Band and In-Band Interference

Coexistence Case #2: LTE vs. DVB-T: Protection Ratio Recommendation

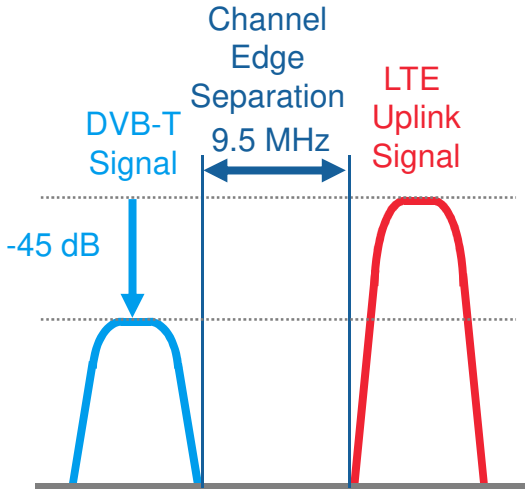
Channel edge separation: distance of victim channel edge to unwanted signal channel edge
PR = Protection Ratio

DVB-T PR for 64-QAM 2/3 DVB-T signal (LTE UE TPC off)									
Channel edge separation (MHz)	PR (dB)								
	10th			50th			90th		
	Can STB/iDTV	Silicon STB/iDTV	Silicon USB	Can STB/iDTV	Silicon STB/iDTV	Silicon USB	Can STB/iDTV	Silicon STB/iDTV	Silicon USB
co-channel	13 … 18	13 … 18	NA	18 … 19	18 … 19	NA	20 … 22	19 … 22	NA
1.5	-28 … -14	-15 … -14	-28	-21 … -13	-14	-23	-14 … -12	-13	-18
9.5	-51	-51	-43	-48 … -47	-49 … -42	-37	-45 … -42	-46 … -32	-31
17.5	-36 … -35	-34 … -31	-45	-49 … -48	-31 … -43	-39	-43 … -40	-48 … -35	-32
25.5	-63 … -59	-56 … -55	-47	-61 … -57	-52 … -46	-39	-59 … -54	-48 … -36	-31
33.5	-70 … -62	-57 … -53	-49	-67 … -56	-54 …-45	-40	-63 … -50	-51 … -37	-31
41.5	-79 … -63	-61 … -52	-49	-73 … -56	-53 … -45	-40	-66 … -49	-45 … -38	-31
49.5	-76 … -66	-60 … -56	-49	-74 … -57	-56 … -48	-40	-71 … -47	-51 … -40	-30
57.5	-77 … -66	-62 … -55	-49	-78 … -59	-55 … -46	-40	-70 … -52	-48 … -37	-30
65.5	-63 … -54	-63 … -52	-47	-50 … -44	-55 … -45	-40	-38 … -33	-47 … -37	-32

Table 7a: DVB-T PR values in the presence of a LTE-UE interfering signal without TPC in a Gaussian channel environment at the 10th, 50th and 90th percentile: comparison between can-tuners and silicon-tuners.[4]

-45 dB as typical protection ratio at 9.5 MHz CH-edge-to-CH-edge distance to keep the defined minimum DVB-T receiver performance

How to read the table:



…at the DVB-T receiver

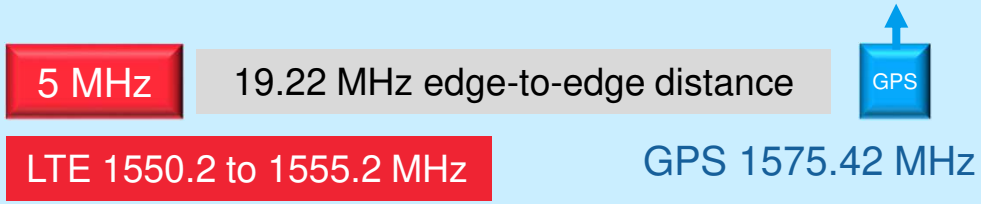
Source of table: ECC report 148 from 2010

Coexistence Case #3: LightSquared Case

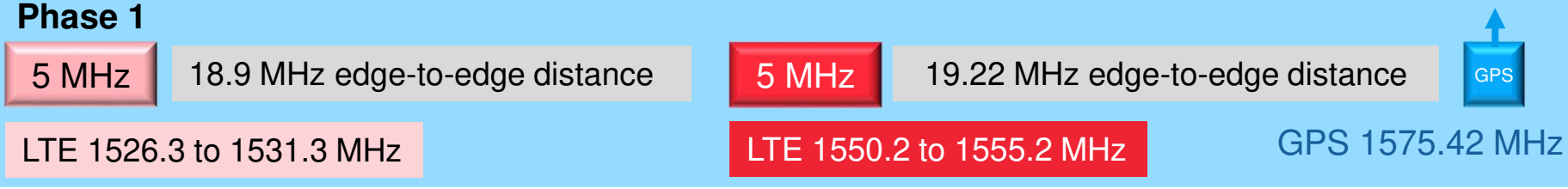
LTE at 1552.5 MHz vs. GPS at 1575.42 MHz

Original Roll-out Plan:
Phase 0 →Phase 1 → Phase 2

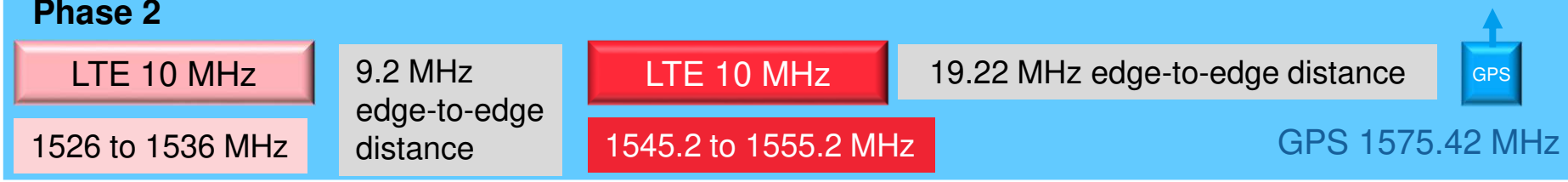
Phase 0



Phase 1



Phase 2



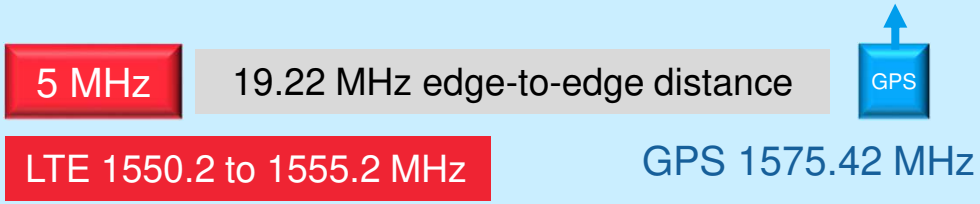
Coexistence Case #3: LightSquared Case

LTE at 1552.5 MHz vs. GPS at 1575.42 MHz

Original Roll-out Plan:
Phase 0 → Phase 1 → Phase 2

Phase 0

The distance of 19 MHz was not enough.



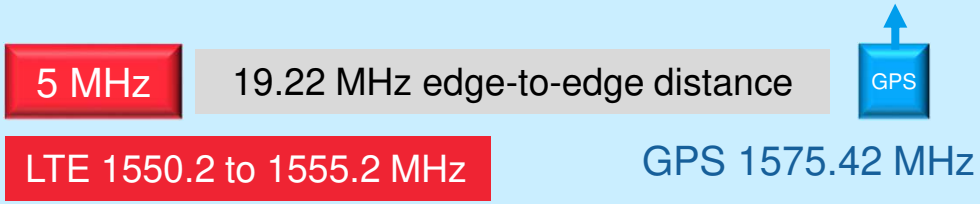
Coexistence Case #3: LightSquared Case

LTE at 1552.5 MHz vs. GPS at 1575.42 MHz

Original Roll-out Plan:
Phase 0 → Phase 1 → Phase 2

Phase 0

The distance of 19 MHz was not enough.



The license for the LTE downlink in the assigned frequency range had been officially granted.
Already Phase 0 caused problems in various GPS applications, including MIL applications.
After the indication of problems NPEF investigated all 3 phases in lab environment.
Conclusion: the LTE base stations in the frequency range 1550.2 to 1555.2 MHz had to be switched off.
Based on this background, the GPS innovation alliance pushed the criterion „C/N0 degradation ≤ 1 dB in the presence of a defined AWGN interferer“ as neutral criterion in the ETSI standardization for GNSS, without disclosing further receiver performance details on e.g. military applications.The inputs have been regarded in EN 303 413 .

Coexistence Case #4:

Co-Location under FCC → recommended Practice for Risk Assessments

- The co-location test requirement addresses the simultanous operation of two or more transmitters in one device.
  The simultanous operation of the intentional transmitters can cause intermodulation.

- The negative effect of intermodulation are additional spurious emissions.

- The co-location test procedure is required to show evidence, that the additional spurious caused by intermodulation are also within the spurious emission limits.
  The co-location test is required, independent from the signal technology

- Procedure (example for 2 transmitters A +B):
  1) spurious emission test of TX A only →keep the limit
  2) spurious emission test of TX B only → keep the limit
  3) spurious emission test of the combination TX A + TX B → keep the limit
  additional spurious may occur due intermodulation effect (non-linear operation of amplifiers)

“Blocking Test” by different Standards

The different standards do not follow a common base line.

From
very simple settings with fixed blocking level and CW signal

via CW signal with level adjustement

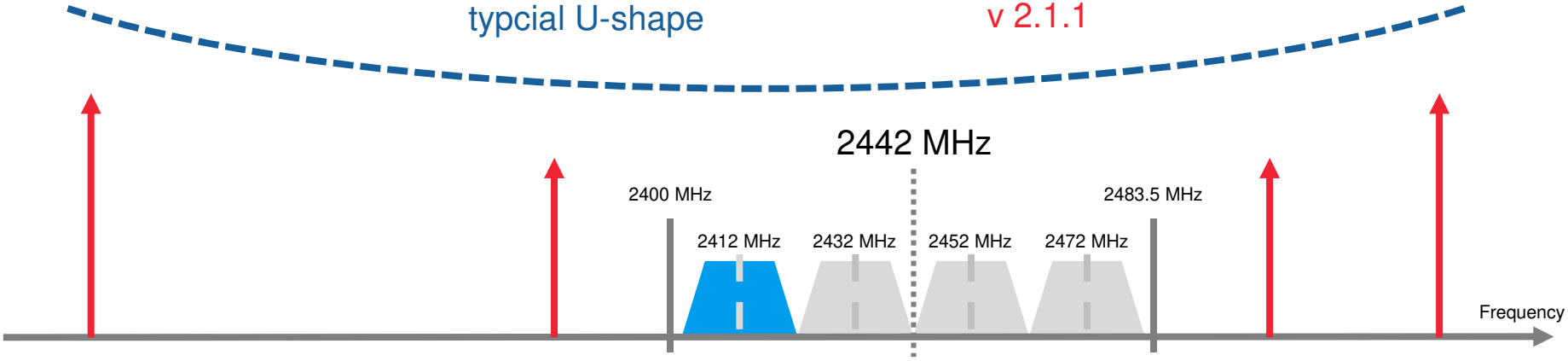
to
the full set of scenarios with variation of signal type and with level adjustement.

Evaluation of Rx Performance Degradation

Fixed blocking signal Levels for in 2.4 GHz ISM band in EN 300 328

10% PER Degradation Line
in the presence of a CW interferer:
typcial U-shape

Blocking signal positions
according to EN 300 328
v 2.1.1



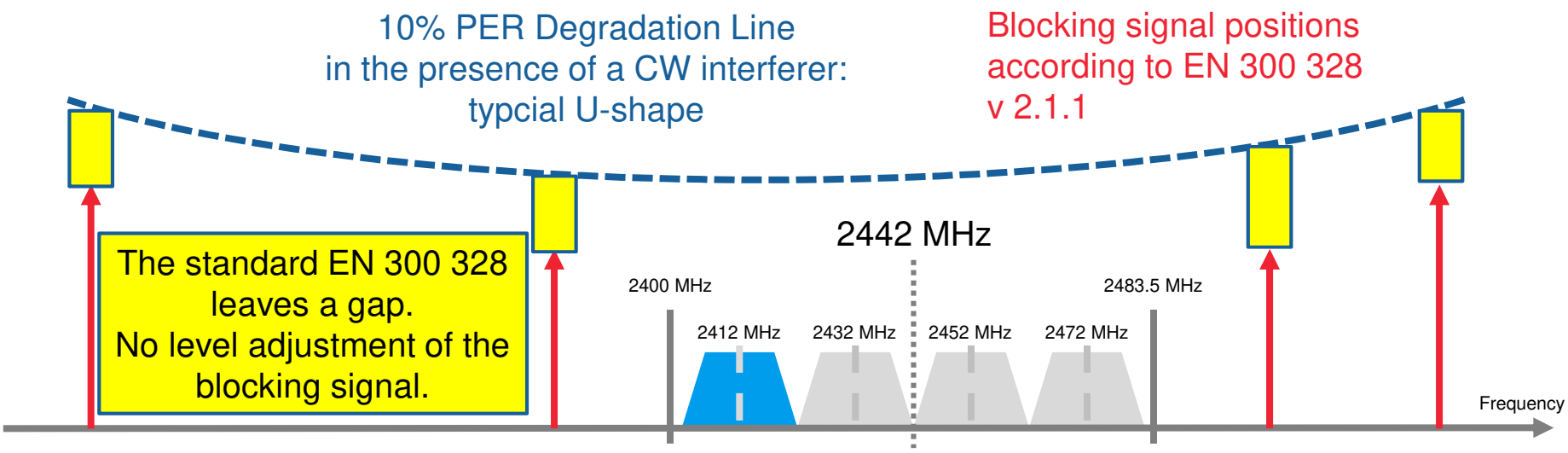
The standard EN 300 328 v 2.1.1 does
not require a level adjustment
to reach a specific degradation limit

Smallest BW with lowest data rate shall be used.→ This not in line with the performance the end-user may expect.

Category 2
Receivers

Evaluation of Rx Performance Degradation

Fixed blocking signal levels for 2.4 GHz ISM band in EN 300 328



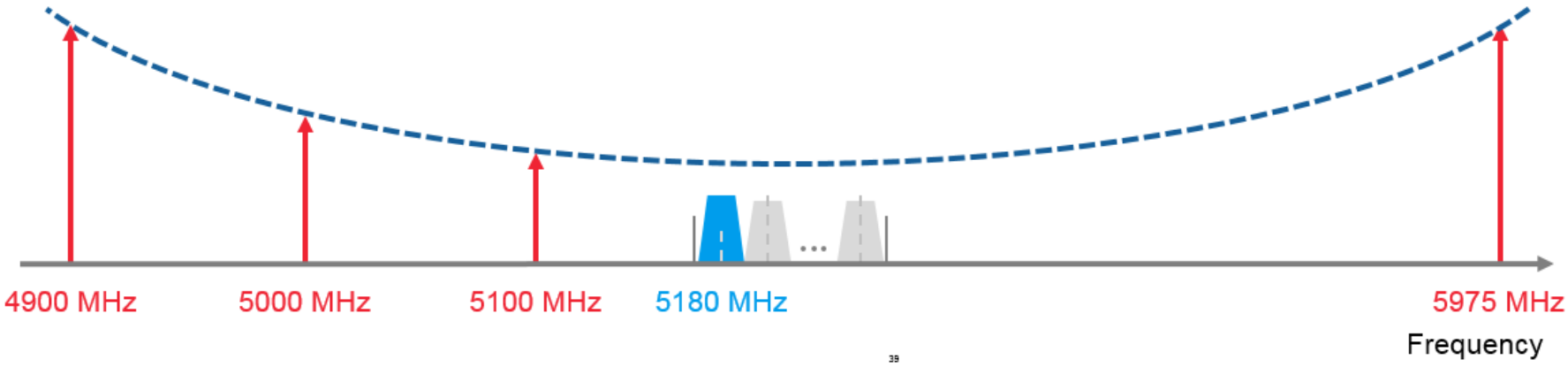
The standard EN 300 328 v 2.1.1 does not require a level adjustment to reach a specific degradation limit

Smallest BW with lowest data rate shall be used.→ This not in line with the performance the end-user may expect.

Category 2 Receivers

Evaluation of Rx Performance Degradation

Level ajustment of blocking signal levels for 5 GHz RLAN in standard EN 301 893

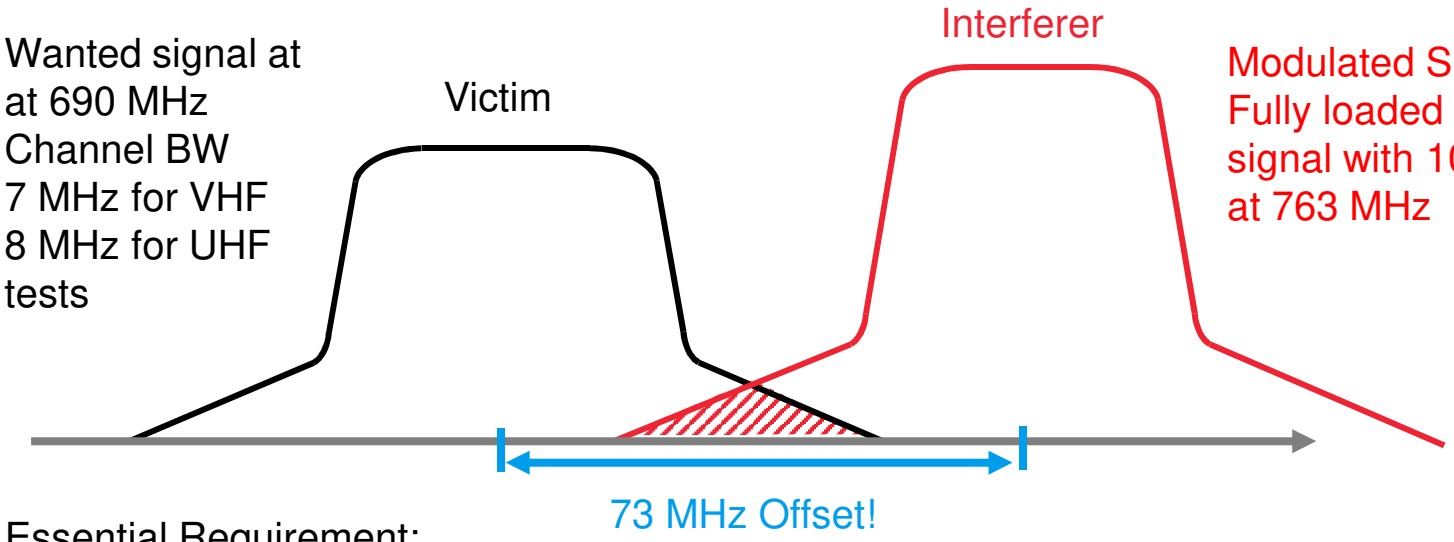


Example for modulated Interferer: Blocking Test in EN 303 340

Digital Terrestrial TV Broadcast Receivers

Example for DVB-T

Wanted signal at
at 690 MHz
Channel BW
7 MHz for VHF
8 MHz for UHF
tests



Modulated Signal:
Fully loaded LTE BS
signal with 10 MHz BW
at 763 MHz

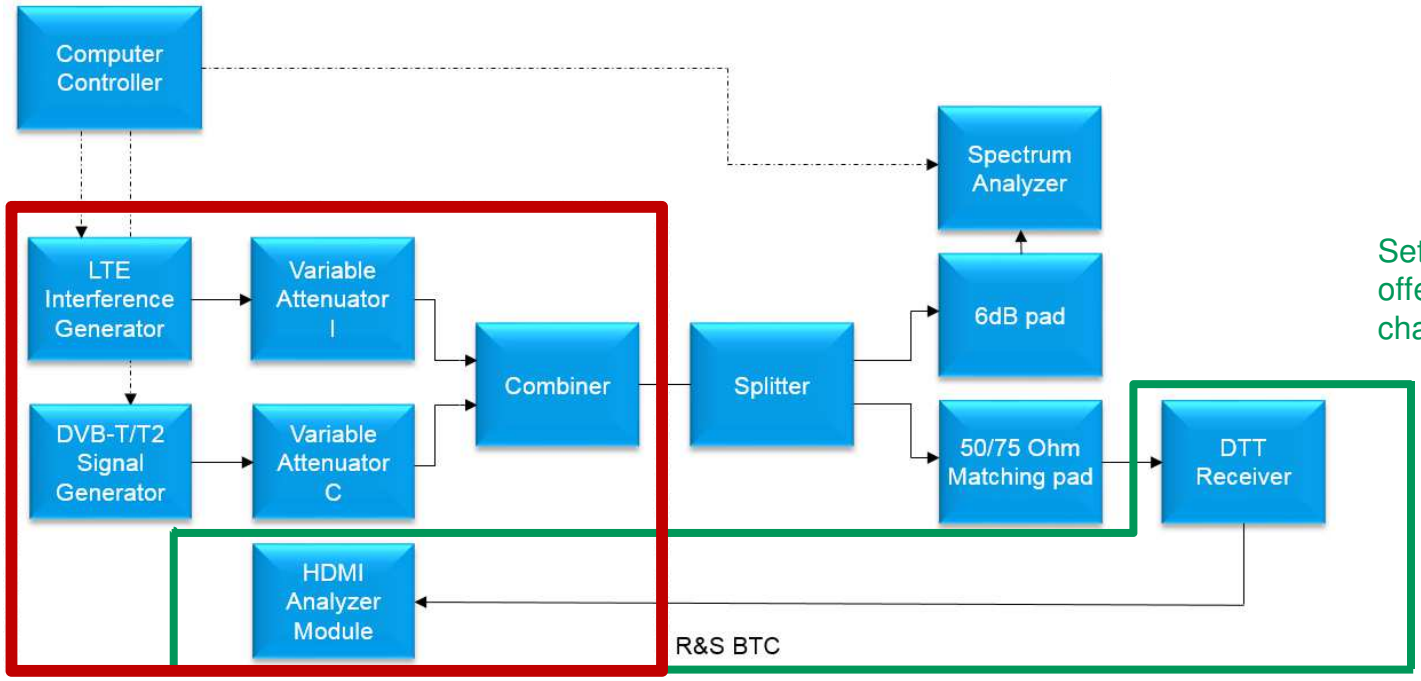
Essential Requirement:
Check of Receiver Performance.

Blocking Test in EN 303 340:

Challenge: Check of Receiver Performance

Interferer Scednario +
Check of Receiver Performance
provided by R&S BTC

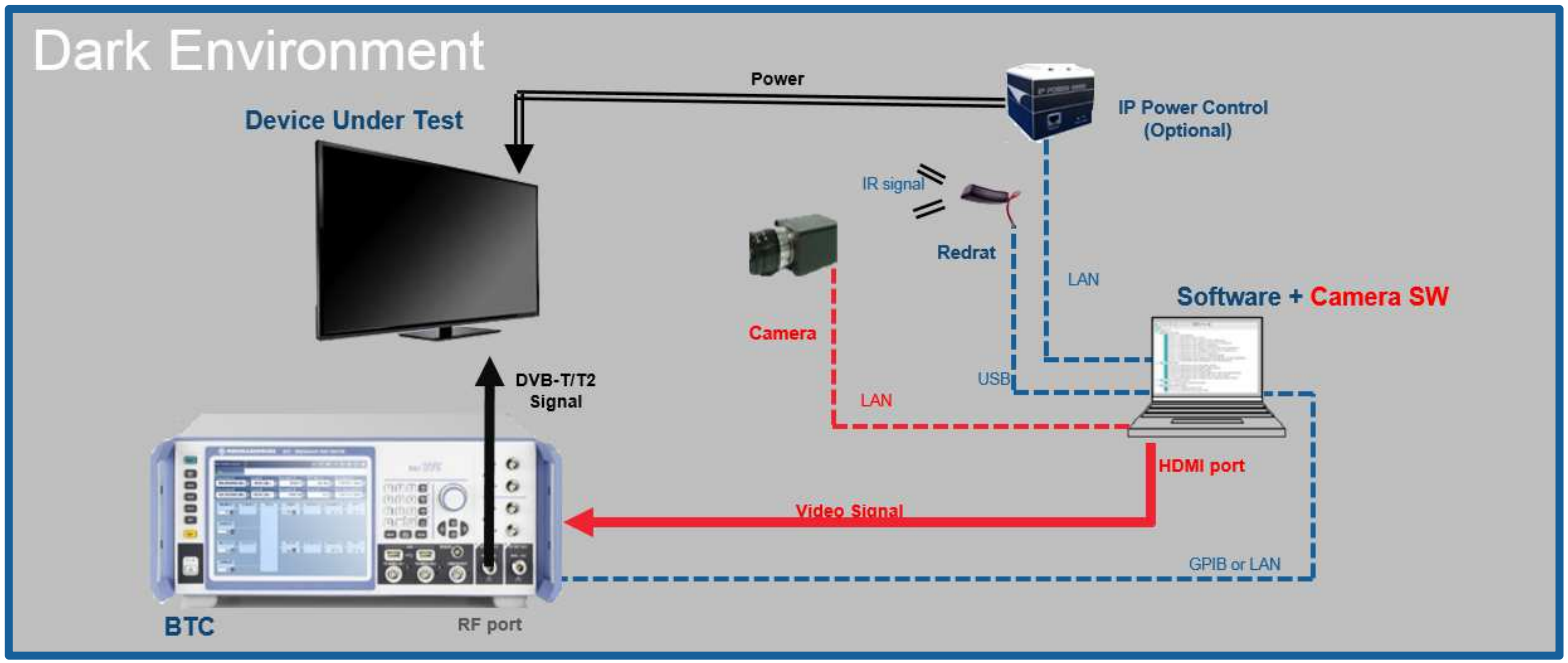
R&S BTC



Set-top box
offers a feedback
channel via HDMI

Blocking Test in EN 303 340:

Challenge: Check of Receiver Performance



The prokect department of R&S Asia in Singapur has developed a system solution for the test of TV sets.

Working with Save-and-Recall Files

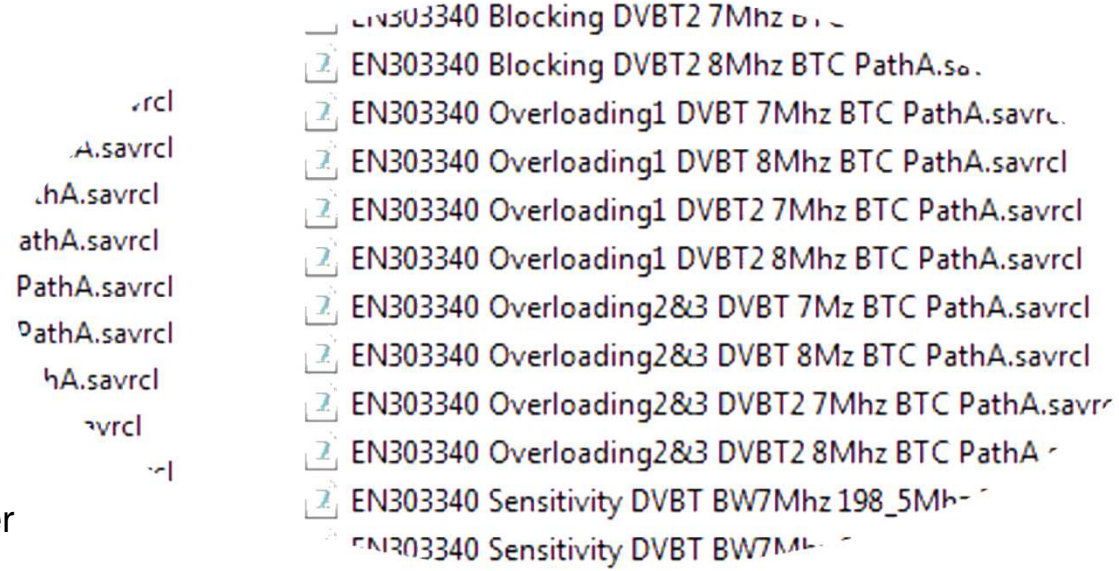
(.savrcl Files)

Standard Scenario Interferer type Type of wanted signal

For Digital TV the interferer signal level has to be increased until the receiver provides with just sufficient performance.

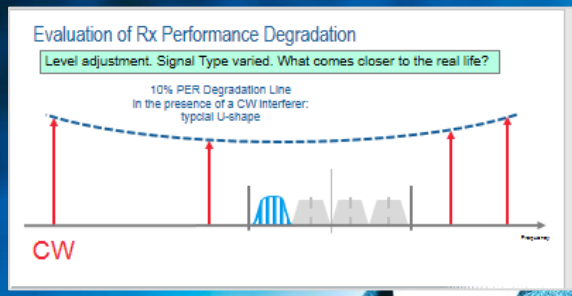
The standard prescribes a minimum period of 15 seconds for the interval between two errors.

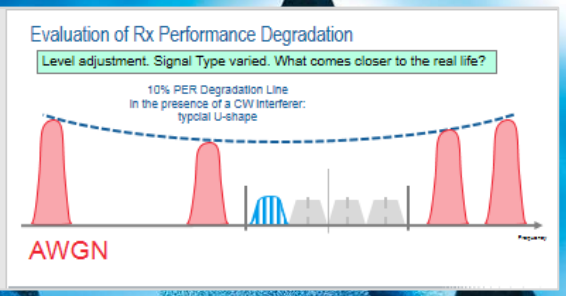
This leads to observation times of 30 seconds per interferer level value. The video must be seamless to avoid synchronisation errors of the device under test.

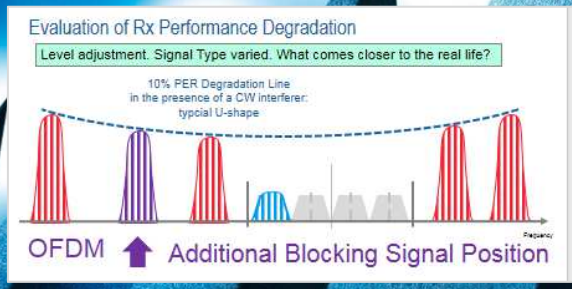


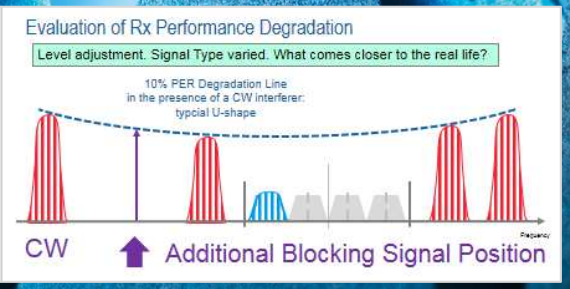
Wireless Coexistence – Risk Assessment

Combining, selecting, adjusting scenarios – important part of Risk Assessment



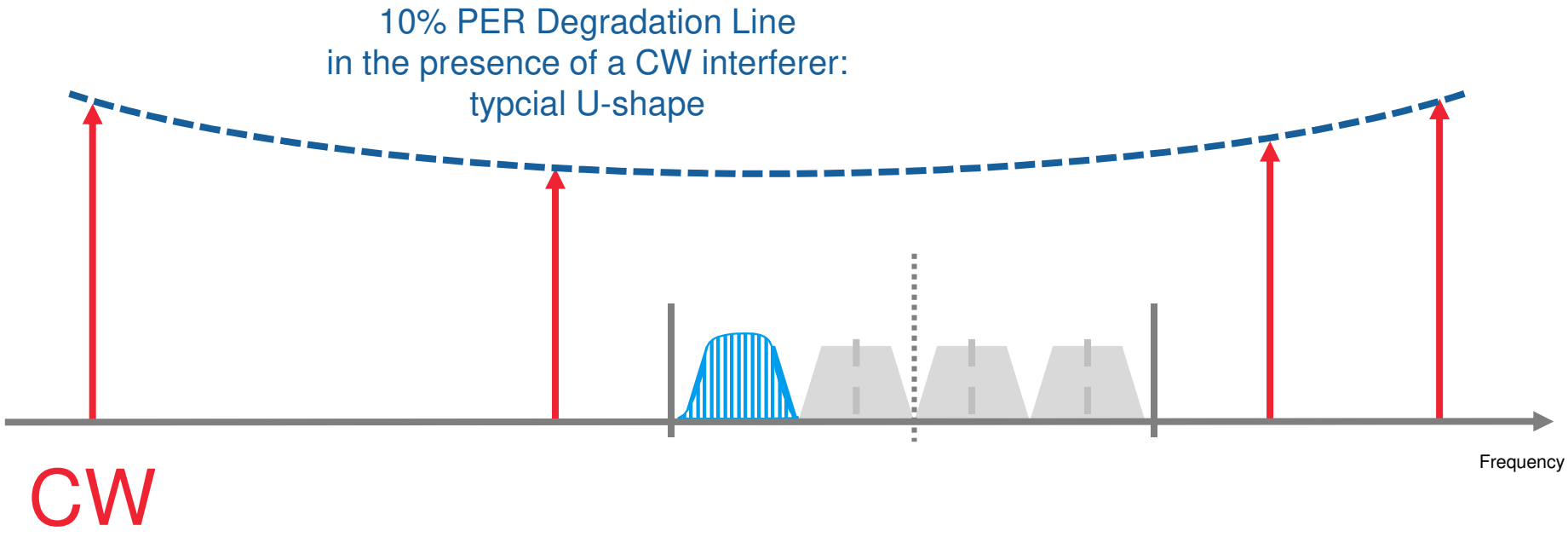






Evaluation of Rx Performance Degradation

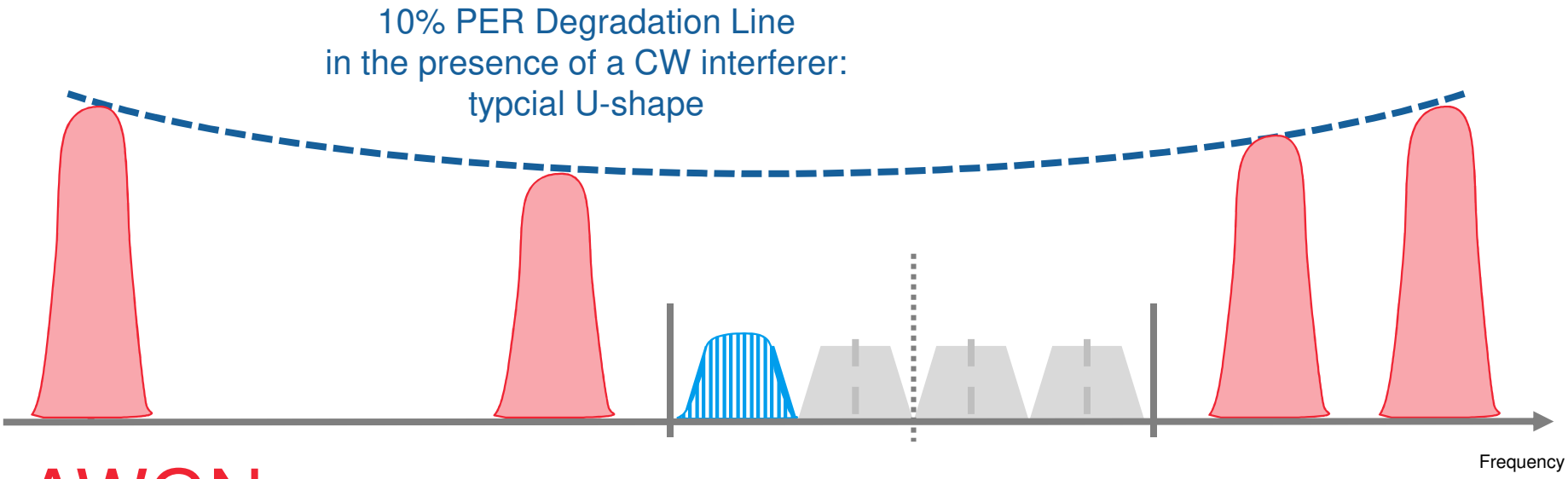
Level adjustment. Signal Type varied. What comes closer to the real life?



CW

Evaluation of Rx Performance Degradation

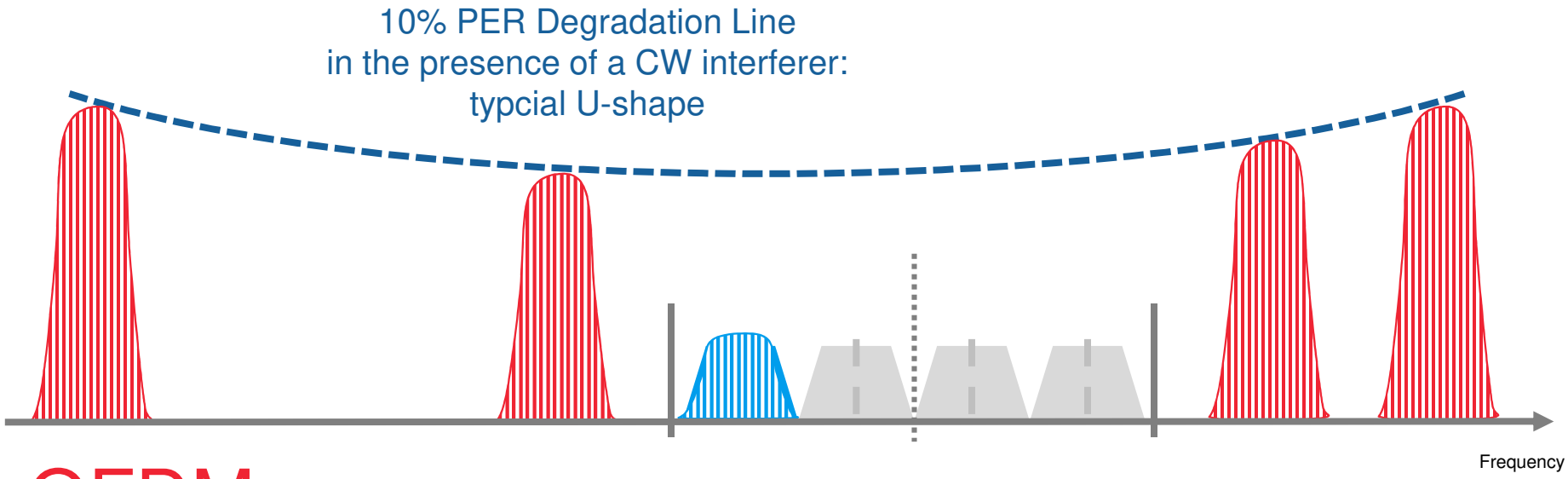
Level adjustment. Signal Type varied. What comes closer to the real life?



AWGN

Evaluation of Rx Performance Degradation

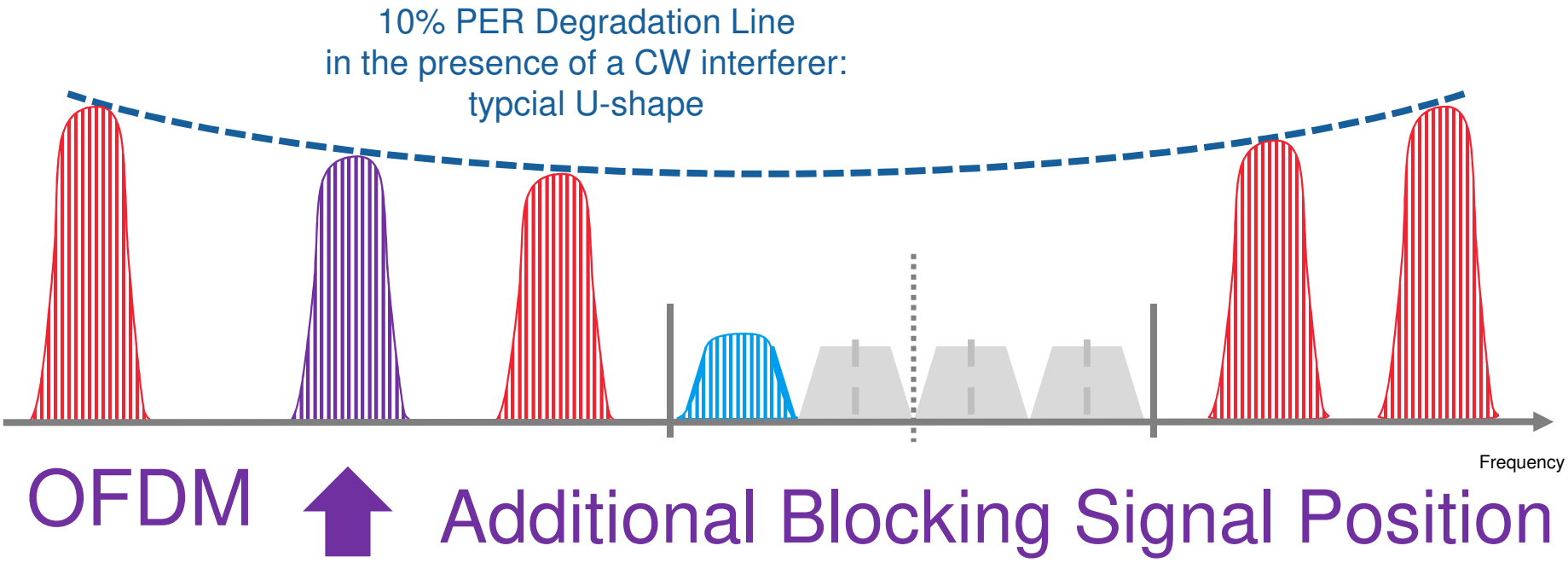
Level adjustment. Signal Type varied. What comes closer to the real life?



OFDM

Evaluation of Rx Performance Degradation

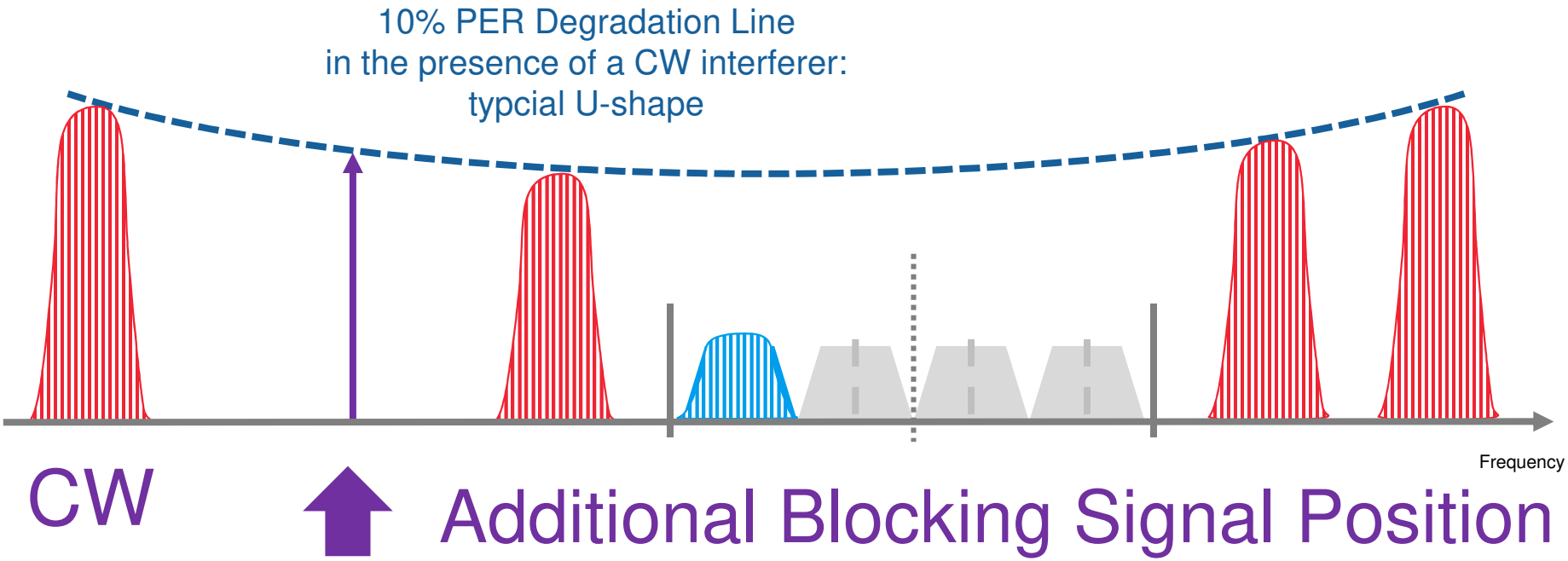
Level adjustment. Signal Type varied. What comes closer to the real life?



OFDM ⬆ Additional Blocking Signal Position

Evaluation of Rx Performance Degradation

Level adjustment. Signal Type varied. What comes closer to the real life?



Tools for Field Strength and Power Discussion

Be careful:
Most tools allow the evaluation of power and fieldstrength conditions for „RMS“.
For active RF signal paths you need to consider the Peak-to-Average Power Ratio PAPR (→Crest Factor).
Typical PAPR values can be derived from technical studies.
A PAPR of 8 dB is often used for LTE signal types.

Field Strength and Power Discussion

Scenario
Separation distance.
Interferer signal EIRP at origin.
Expected fieldstrength of the „unwanted signal“ at the UUT (victim).

Simulation by immunity system
Expected field strength at UUT.
Distance between UUT and antenna for the transmission of the unwanted signal. Antenna gain.

RMS power level
Calculation of the transmit power level of the unwanted signal at the antenna input.

Additional Factors
- number of subcarriers
- Bandwidth correction
  e.g. in case of transient interferers.

Crest Factor, PAPR
Typical for LTE: 8 dB

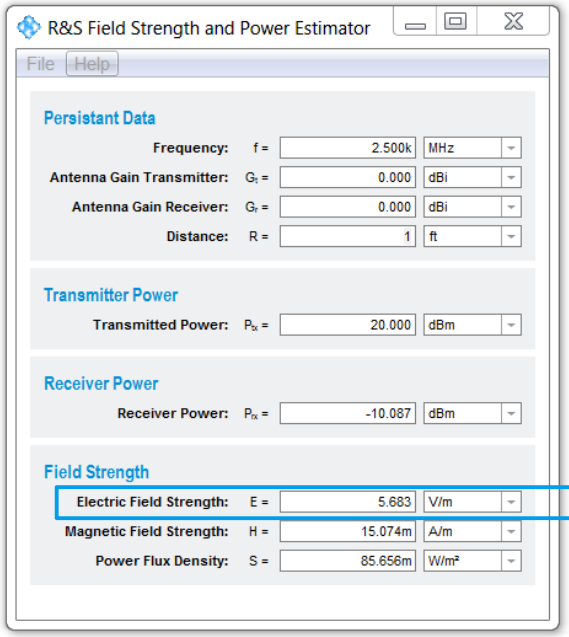
Be careful:
Most tools allow the evaluation of power and fieldstrength conditions for „RMS“.
For active RF signal paths you need to consider the Peak-to-Average Power Ratio PAPR (→Crest Factor).
Typical PAPR values can be derived from technical studies.
A PAPR of 8 dB is often used for LTE signal types.

More details follow later.

Tools for Field Strength and Power Discussion

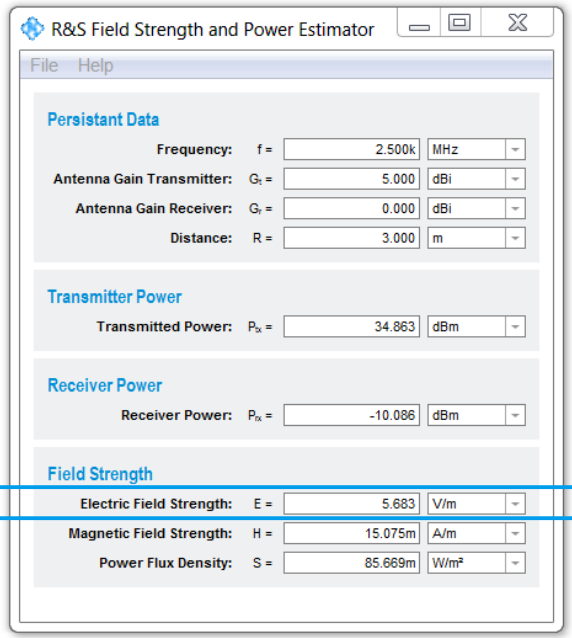
Example

Scenario



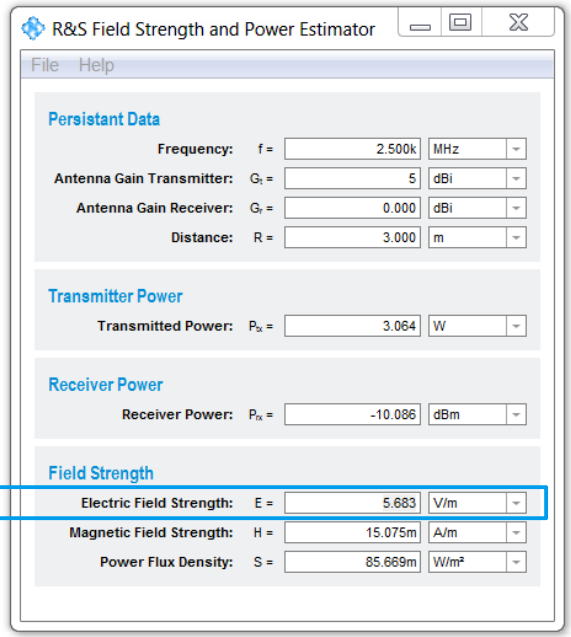
1 ft separation. EIRP (unwanted)
20 dBm at 2.5 GHz

Simulation by immunity system



Keep the field strength. Put in the
setup parameter, e.g. 3 m. Gain 5 dBi.

RMS power level

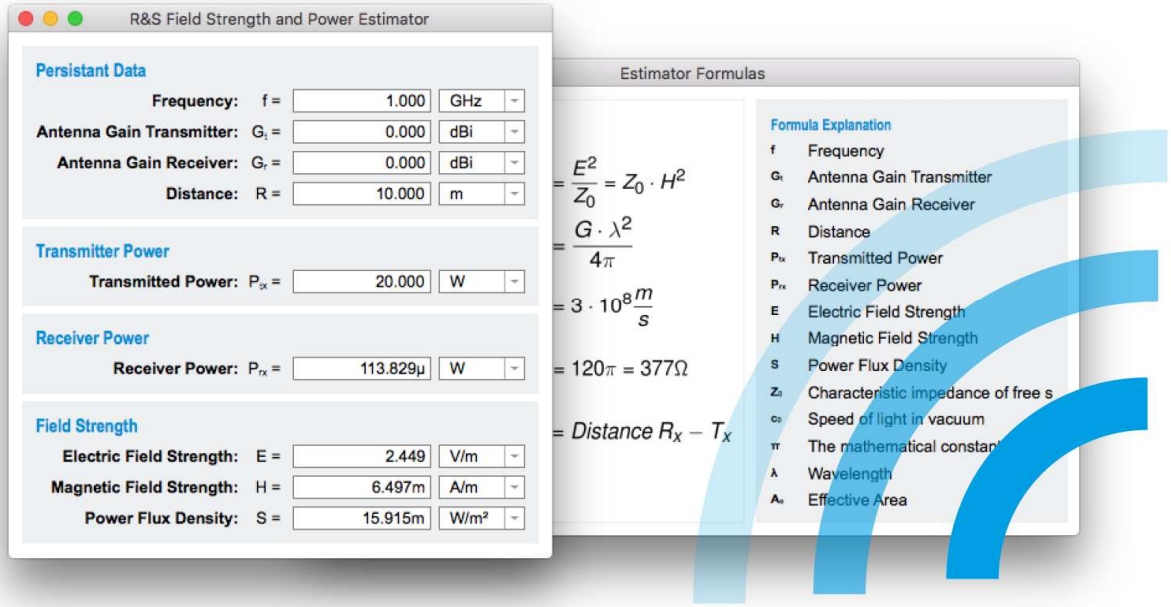


Required power for RMS: 3 Watt.
Additional head room to cope with the PAPR
of the unwanted signal: 8 dB → 19.3 Watt (net).
Losses of 1.5 dB? → 27.3 Watt → select 30 W.

Fieldstrength and Power Discussion

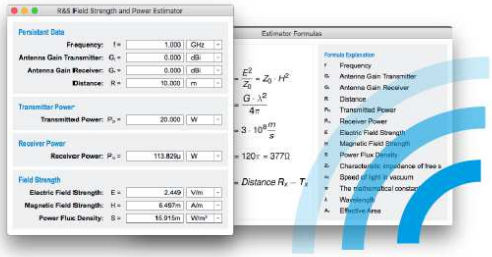
R&S Field Strength and Power Estimator

Application Note 1MA85



Application Note 1MA85

Field Strength and Power Estimator
Application Note



Determining the field strength from transmitted power is not an easy job. Various, quite complicated formulas have to be evaluated correctly. This application note explains how to calculate electric and magnetic field strength, and power flux density. A program associated with this application note helps with the calculation and converts Watts to mW and dBm, V/m to µV/m and dBµV/m as well as A/m to µA/m and dBµA/m. Additional applications are calculation of propagation loss or antenna factor. Smartphone versions of the application software are also available.

Note:

Please find the most up-to-date document on our homepage http://www.rohde-schwarz.com/appnote/1MA85.

This document is complemented by software. The software may be updated even if the version of the document remains unchanged

Abbreviations

- ACS Adjacent Channel Selectivity
- AFA Adaptive Frequency Agility
- AWGN Additive White Gaussian Noise
- CCA Clear Channel Assessment
- DFS Dynamic Frequency Selection
- LBT Listen Before Talk

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