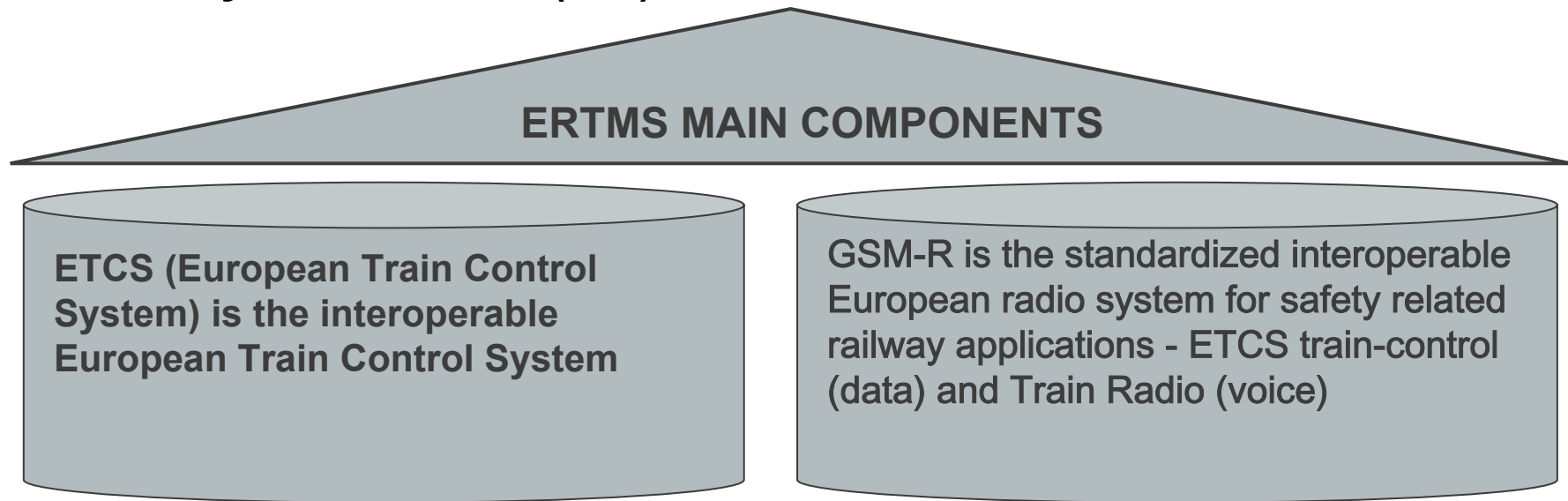


# Interferences into GSM-R due to public mobile radio networks



**ERTMS (European Rail Traffic Management System) is the interoperable European system for management and control of railways traffic, mandated by EU Directive (TSI).**



The digital radio system GSM-R is an indispensable constituent for the present and future interoperable European railway operations.

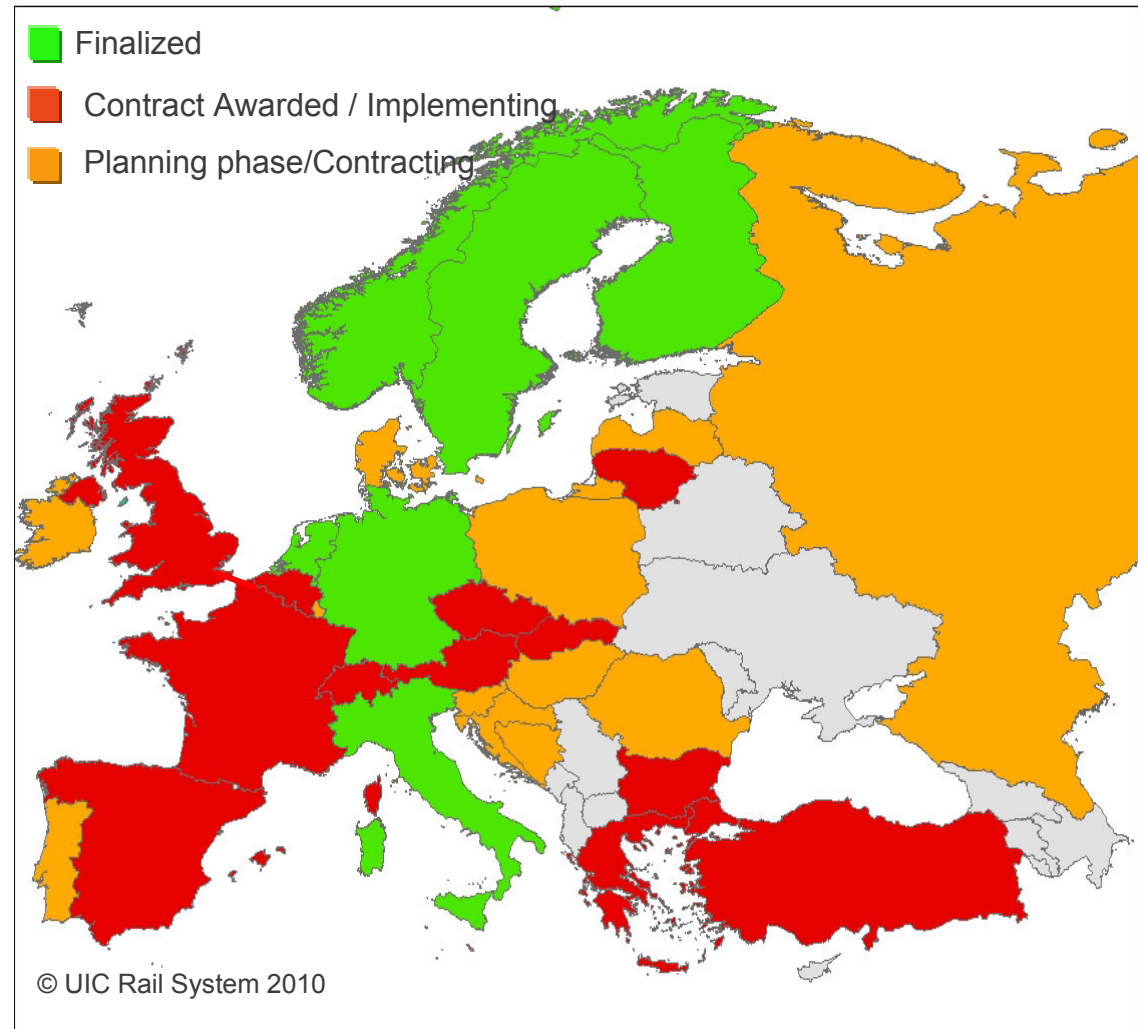
GSM-R is specified in Control-Command & Signaling TSI as part of ERTMS, Railways will implement ETCS and GSM-R on all interoperable high speed and conventional lines.

Scope extension for the TSI is currently under discussion.

# GSM-R Implementation status in Europe

GSM-R is in advanced implementation in all Europe.

- Over 160.000 km of rail will be covered with GSM-R by 2016 in Europe; 60.000 Km are already in operation!
- 40.430 Cab Radios and 118.000 handhelds are today activated
- GSM-R International operations - essential for interoperability - are currently well ongoing



# Interferences into GSM-R in Europe

- The EC and the EU Member States have taken several measures in order to push forward the development of new mobile communication technologies such as UMTS and LTE in the 900 MHz band.
- Railways are registering an increasing number of interferences to the GSM-R systems. By January 2011 there was an identified number of 252 interference locations in Germany (compared to 58 locations in 2006) - where interference from public mobile GSM networks have been measured;
- Further 180 locations in other EU countries have been reported to UIC.
- We expect that the number of cases will significantly increase:
  - In most countries GSM-R implementation has not been completed;
  - the implementation of ETCS level 2, based on GSM-R has not been completed
  - the implementation of UMTS 900 MHz has only started in Europe and other new technologies - i.e. LTE, WiMAX - are only now emerging in 900 MHz bands

# Description of the problem

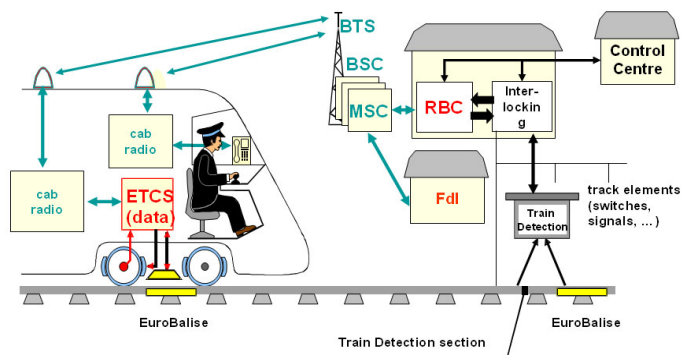
- Unwanted emission coming from the public base stations (GSM, UMTS900, LTE900) which may leak into the GSM-R band and therefore raise the noise floor.
- Cumulated interferences signal level, due to high transmitting levels from public transmitters.
- All of the above, in combination with future systems installations close to railway lines without coordination, will cause severe interference to the GSM-R communications on railways lines.

## Note:

- Better GSM-R mobile receivers according to the improved ETSI standard can only help in limited cases (limited efficiency, equipment not available; change of all mobiles in the train necessary - which is time and cost intensive and needs harmonization)
- In case of new technologies (UMTS, LTE, WiMax), technical measures are possible only on public operator side; no relevant technical solution on GSM-R side available

# Operational and commercial consequences for ETCS

- ETCS Level 2 is based on radio train-ground transmission of data. No track-side signals!
- For each train, movement orders and the train position on the track are exchanged in time critical sequences via GSM-R; a strong Quality of Service is required (e.g.) - practically uninterrupted radio-link; end to end delay of 500 ms; one dropped call for 100 functioning hours - vital requirements for railway operations.
- The consequences of interfered GSM-R on ETCS level 2 are severe (e.g.):
  - No Movement Authority (MA) transmission in due time forces the trains to stop
    - All traffic is jammed – major delays;
    - Performance of line and rail network is badly affected;
    - Increased energy consumption and overall bad economic consequences;



**There is a danger, that ETCS Level 2 reduces performance at unacceptable level, which is commercially and politically unacceptable.**

# Operational and commercial consequences for Train Radio

- GSM-R is the interoperable communication platform of Train Radio (train drivers and dispatchers communications), including Railway Emergency Call, which is the fastest, most effective and often the only remaining method to avoid dangerous situations, minimizing the consequences of such situations

## **The consequences of disturbances with regard to train-radio are also severe**

- Interfered GSM-R is equivalent to connection loss:
  - Degraded mode of operation, resulting in delayed trains and bad economic and commercial effects
  - Impossibility of Railway Emergency Calls (REC) - can lead to dangerous situations



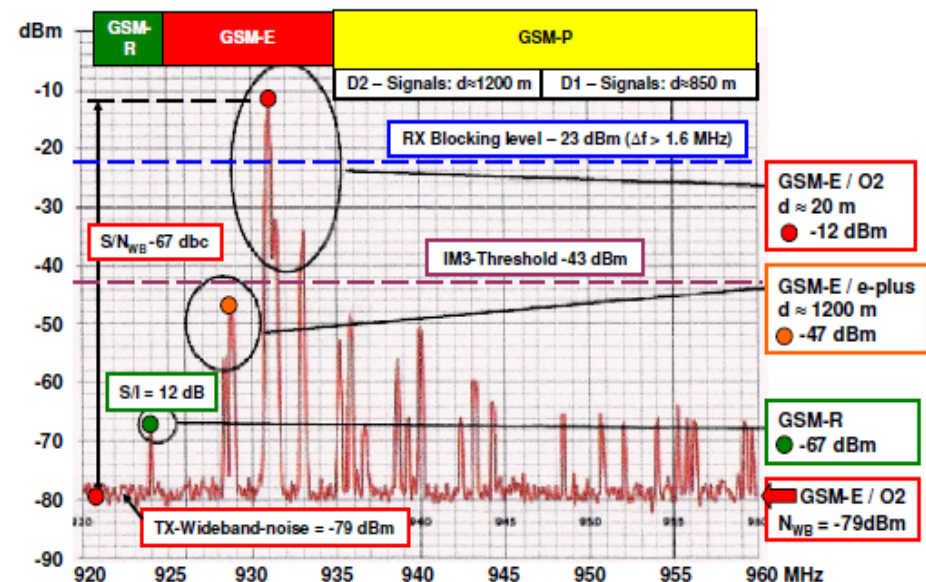
In the impacted train-radio sectors it is not possible to warn trains or to arrange support and help in case of danger.

Operational fall-back solutions (e.g. public roaming) do not provide the same quality of service (safety, reliability), and require additional resources.

# Interference to GSM-R - example



- Since 2005 a GSM-R Site for Railway Stop “Völksen” in operation without any interference
- Starting 2007 DB is facing severe interferences
- German Regulator has carried out test campaign
- Results:
  - GSM-R Site performs very good Rx lev ( $\geq -70$  dBm)
  - O2 Site performs with very high Rx lev (-12 dBm)
  - This extremely high field strength leads to call drops and network loss for the GSM-R Cab Radio
- All Site-Parameters are within the specification of the German Regulator
- In its report the German Regulators advices a redesign of the O2 Site
- O2 does not change GSM Site-Design



GSM-R Antenna: Receive level display at Völksen-Station

D1 GSM-P Base Station Signals are strongly shadowed ( $d \approx 850$  m, Level  $\leq -64$  dBm)

# Railways have started all possible technical measures they are able to take; trying at least to partly cover the already existing effects

## Existing GSM technology disturbances

- Measures are not successful in all identified situations;
- Cost for rail is very high – not acceptable;
  - Need of additional Base Stations - can not be installed in all cases
  - Need new mobile equipment; not yet available, with limited efficiency
- All such measures need several years for realization - how many trains will be at still-stand?
- Solutions are not harmonized and therefore interoperability is no more granted!

## Upcoming wide-band disturbances (UMTS, LTE-Technology)

- No effect from taken measures
- Heavy increase of interferences expected

**Only harmonized regulation (protection by law + coordination) can be effective European-wide**

# Summary

- Uninterrupted functioning of a mobile radio network is the basis for communication in a modern European railway.
- Railways have started all technical solutions they are able to do - to avoid and to overcome such disturbances; they can only cover a part of these disturbances by technical means (costs, time, interoperability).
- The growing implementation of next generation systems are expected to create interferences that railways are unable to overcome.
- Introduction of new technical coordination at railways initiative on international level have started (e.g. ECC Report 162) and shall lead to actions at national level.
- Railways need urgently a binding regulation at EC level, which clearly binds national regulators. Legal basis: directive 2002-21, Commission Decision 676/2002/EC (article 4) and 2009/766/EC (paragraph 7, article 5) .
- Only political actions can make sure that investments into a future proof European railway are not jeopardized, as there are no other means to overcome the existing and upcoming disturbances situations.

# Expected actions by Railways

We ask RSC, DG MOVE and DG INFSO to:

- take note of the current situation about interferences into GSM-R and their serious consequences to railways operations and to the EC planned deployment of ERTMS;
- confirm the political willingness to protect GSM-R investment as a ERTMS component;
- initiate action at EU level concerning binding protection means; using as a starting point existing documents (e.g. report 162, 96);
- apply the above rules in actions of national authorities by coordination of radio planning between Railway and Public Mobile operators, where railways must be treated as a victim - due to their specificity (safety supporting, strong quality of service); license conditions for public operators (e.g. in-train-coverage) shall not imply a higher level of interference to railways.

# Thank You For Your Attention!



*The Voice  
of European  
Railways*

European Rail  
Infrastructure Managers



GSM-R Interferences – 23 of March 2011



# Backup Slides

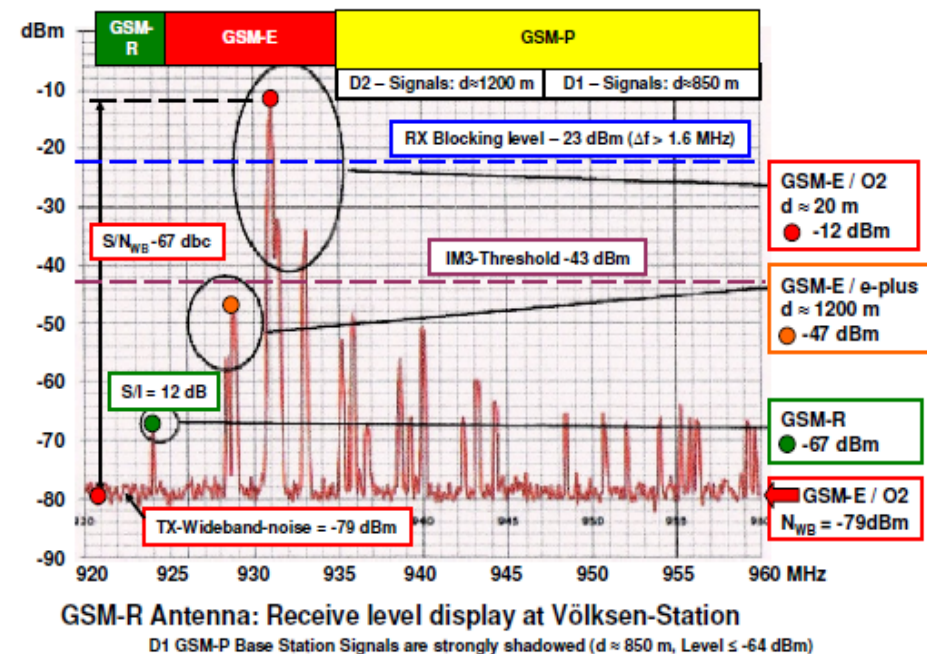
# GSM-R Interferences Country Cases

# Country case - Germany

- 25000 km of tracks are in GSM-R operation
- Start of deployment of GSM-R in 2001, without any interference problems
- Since 2006, an increasing number of interference situations exists, due to the intensive use of the neighboring public GSM band.
- Today we have 252 track location with existing strong interference problems like connection loss of each passing train.
- The German Regulator Authority says that it does not have legal basis to introduce measures to prevent or to avoid the interferences

## Measure taken to prevent/overcome GSM-R interferences

- Implementation of 20 additional GSM-R Base stations
- Round table with public network operators (no real success)
- Triggering international technical actions like:
- ETSI Standard improvement for GSM-R mobiles
- SE 7 measures regarding Report ECC162



# Country case – Finland, UMTS900

- > Existing GSM-R network planning requirement was defined in 2002, when only GSM systems co-existed in 900 MHz band.
- > FICORA)\* issued UMTS900 radio licenses to three existing mobile operators in 2007. This could cause a major change to GSM-R radio environment. Therefore there are special limitations in UMTS900 radio licenses protect GSM-R from interferences:
  - **Maximum UMTS900 signal unwanted out of band emission per operator into the GSM-R down link band was defined to -107 dBm (it can be higher when GSM-R signal level is high enough). => Existing network can be used without rebuilding it because of this limitation.**
  - **Maximum UMTS900 signal level per operator was defined to -23 dBm due to train-radio blocking.**  
**=> Practical measurements have shown that existing train-radios on the market would require approximately -35...-40 dBm limitation to guarantee the proper function without better blocking performance than specified in ETSI specification.**
- > **Issue:**
  - **Current 900UMTS limitations are only valid until October 2012. What will happen to railway communications after 2012 is now unclear!**
  - **Situation is unclear whether there will be similar limitations for other technologies like LTE, or WiMAX in the future.**

)\* FICORA, Finnish Communications Regulatory Authority

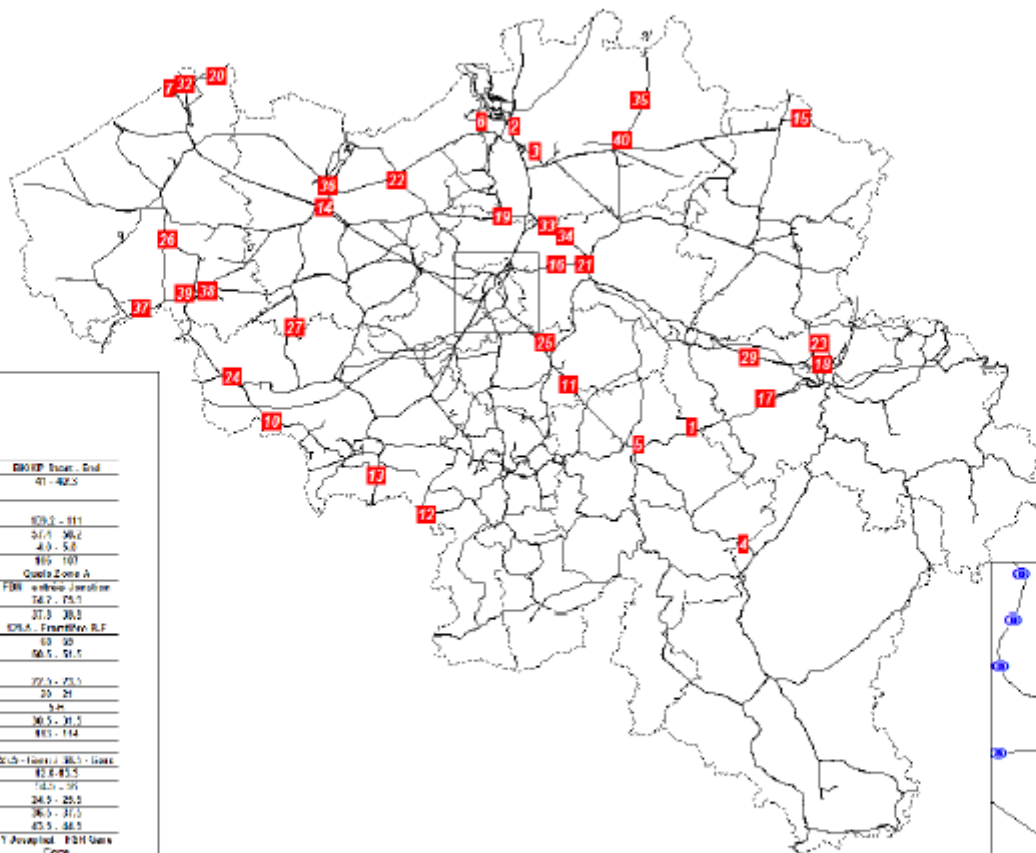
# Country case – Sweden

- > New access technologies - UMTS(HSPA/WCDMA), LTE, WiMAX etc for public mobile communications in the 900 MHz band will in Sweden - to a large extent - use existing GSM900 BTS sites
- > The Swedish regulator, PTS, performed a study in order to understand the implications of the introduction of different protection levels for GSM-R, based on information about:
  - interference parameters for above access technologies,
  - propagation situations of existing and proposed public mobile installations,
  - properties of the GSM-R network -
- > The result is a report showing the public mobile installations that will interfere with GSM-R (with regards to unwanted emissions at certain defined protection levels and the cost for installing necessary rejection filters at the public operators installations. The report also shows how many installations will generate blocking of the GSM-R receiver.
- > PTS has in addition to the study issued a questionnaire to the Swedish Transport Administration, Trafikverket, regarding experienced and necessary blocking properties of the GSM-R receivers.
- > The result of this will likely be a requirement of installation of GSM-R CAB- Radio protection filters in order to allow the public operators use the new access technologies from their sites.
- > PTS will after necessary consultations issue new license limitations to the public operators based on the above study and questionnaire before summer of 2011.
- > At present it seems probable that GSM-R will have to be capable of operating at a composite interference level from unwanted emissions of – 95 dBm, *and also tolerate in-band composite power levels of up to – 10 dBm from the public operators (which is much over the limits agreed within Report 162!)*

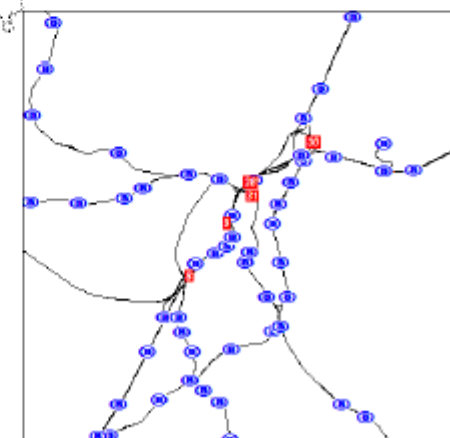
# Country case – Belgium

**GSM-R Belgium - Areas interfered by public operators**  
**Status 15/12/2010**

**INFRABEL**  
 Right On Track



Référence	Nom de la ligne	Coordonnées	Statut
1	Andenne	L120	41 - 42.5
2	Ardenne (Belux)	L120	41 - 42.5
3	Ardenne (Belux)	L120	41 - 42.5
4	Ardenne (Belux)	L120	41 - 42.5
5	Ardenne (Belux)	L120	41 - 42.5
6	Ardenne (Belux)	L120	41 - 42.5
7	Ardenne (Belux)	L120	41 - 42.5
8	Ardenne (Belux)	L120	41 - 42.5
9	Ardenne (Belux)	L120	41 - 42.5
10	Ardenne (Belux)	L120	41 - 42.5
11	Ardenne (Belux)	L120	41 - 42.5
12	Ardenne (Belux)	L120	41 - 42.5
13	Ardenne (Belux)	L120	41 - 42.5
14	Ardenne (Belux)	L120	41 - 42.5
15	Ardenne (Belux)	L120	41 - 42.5
16	Ardenne (Belux)	L120	41 - 42.5
17	Ardenne (Belux)	L120	41 - 42.5
18	Ardenne (Belux)	L120	41 - 42.5
19	Ardenne (Belux)	L120	41 - 42.5
20	Ardenne (Belux)	L120	41 - 42.5
21	Ardenne (Belux)	L120	41 - 42.5
22	Ardenne (Belux)	L120	41 - 42.5
23	Ardenne (Belux)	L120	41 - 42.5
24	Ardenne (Belux)	L120	41 - 42.5
25	Ardenne (Belux)	L120	41 - 42.5
26	Ardenne (Belux)	L120	41 - 42.5
27	Ardenne (Belux)	L120	41 - 42.5
28	Ardenne (Belux)	L120	41 - 42.5
29	Ardenne (Belux)	L120	41 - 42.5
30	Ardenne (Belux)	L120	41 - 42.5
31	Ardenne (Belux)	L120	41 - 42.5
32	Ardenne (Belux)	L120	41 - 42.5
33	Ardenne (Belux)	L120	41 - 42.5
34	Ardenne (Belux)	L120	41 - 42.5
35	Ardenne (Belux)	L120	41 - 42.5
36	Ardenne (Belux)	L120	41 - 42.5
37	Ardenne (Belux)	L120	41 - 42.5
38	Ardenne (Belux)	L120	41 - 42.5
39	Ardenne (Belux)	L120	41 - 42.5
40	Ardenne (Belux)	L120	41 - 42.5



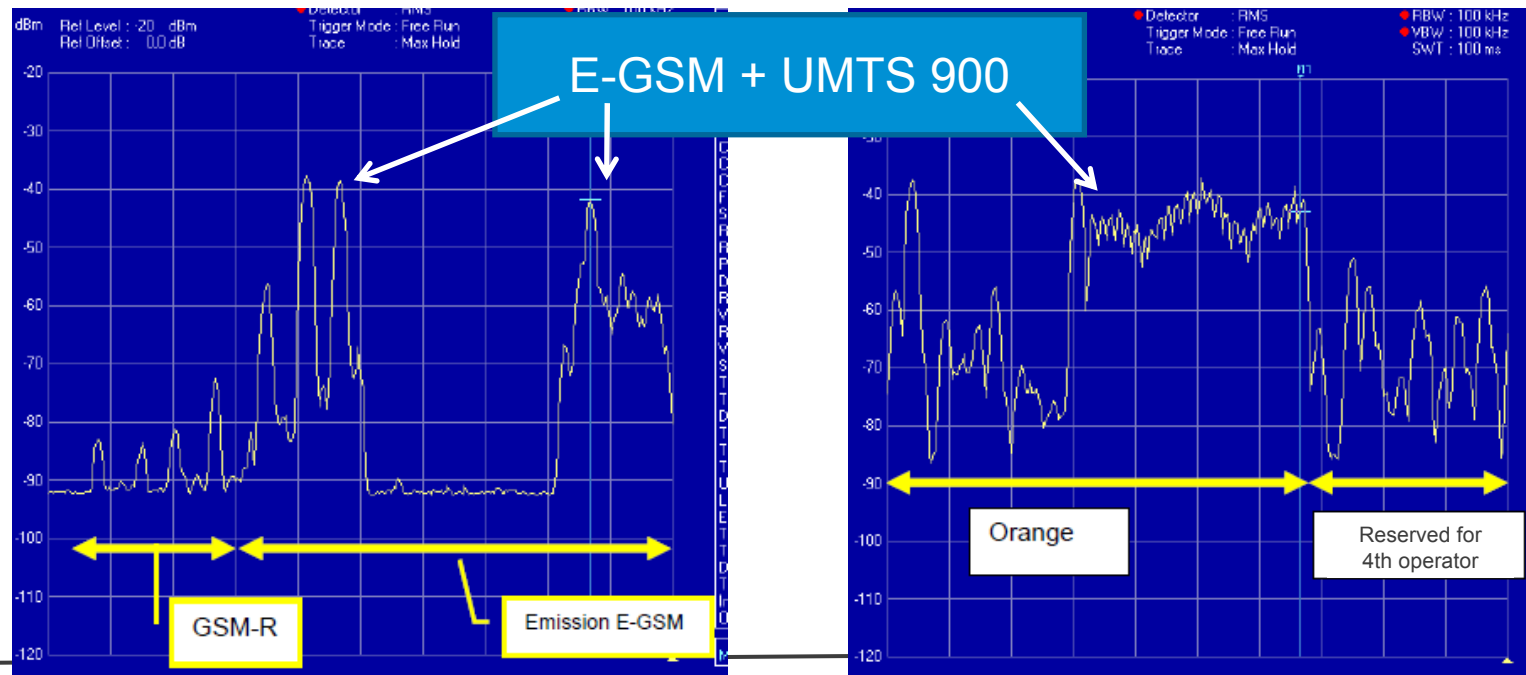
JF Pletquin  
 B-Holding ICTRA 124

**GSM-R interferences – 23 of March 2011**

# Country Case: France (RFF)

Total : 17 occurrences including occurrences below:

- 2 new occurrences confirmed (E-GSM) : Nogent le Perreux and Vaires (suburb areas of Paris)
- 3 additional occurrences still under investigation : Dijon : external interferences confirmed, exact causes still under investigation (probably due to cumulated inferences from E-GSM and UMTS 900)



GSM-R Interferences – 23 of March 2011

# Radio interferences in France

Quarter of disturbance detection	Name of disturbance location	Disturbance position rural / urban	Description of impact	Voice service impacted	Severity of voice impact
2006 Q2	La Villette	urban	drop call	Voice (operation critical)	Critical
2008 Q4	Strasbourg Holzmatt	rural	RxQual between 4 and 6	No impact on Voice quality	minor
2008 Q4	Duppigheim	rural	RxQual 5	No impact on Voice quality	minor
2008 Q4	Strasbourg Port du Rhin	rural	RxQual 7	Minor voice impact	minor
2008 Q4	Geispolsheim	rural	RxQual 6	Minor voice impact	minor
2008 Q4	Matzenheim	rural	RxQual 4	No impact on Voice quality	minor
2009 Q1	Mouaville	rural	RxQual 6	Minor voice impact	minor
2009 Q1	Mars La Tour	rural	RxQual 4	No impact on Voice quality	minor
2009 Q1	Distroff	rural	RxQual 4	No impact on Voice quality	minor
2009 Q1	Woippy	rural	RxQual 5	No impact on Voice quality	minor
2009 Q2	Omiecourt	rural	RxQual between 5 and 6	No impact on Voice quality	minor
2009 Q4	Bouleuse	rural	drop call	Voice (operation critical)	Major
2010 Q4	Vaires	urban	drop call	Data (ETCS)	Major
2010 Q4	Nogent	urban	drop call	Data (ETCS)	Major
2011 Q1	Dijon centre	urban	drop call	Voice (operation critical)	Critical
2011 Q1	Dijon Perigny	urban	drop call	Voice (operation critical)	Major
2011 Q1	Nuit saint George	rural	RxQual between 4 and 5	Voice (non operation critical)	minor

GSM-R Interferences – 23 of March 2011

# Country case – Netherlands

- **Radio problems due to interference/blocking reported on 12 locations, only GSM E-band related, BUT:**
  - New Licensing of all 800/900/1800/etc public frequencies is ongoing, ProRail tries to convince the Regulator to set signal strength limits around tracks
  - Coordination on political level is organized (Ministry of Economic Affairs, Ministry of Transport, ProRail, Public operators, Frequency Regulator)
- **Coordination on operational level is started**
  - Reduction of power is always discussion
  - Using other frequencies is ongoing, but not always helps
- **Operational impact on some locations is serious**
  - Railway safety is questioned
  - Traindelays on ETCS lines
  - Disturbance of Passenger Information (displays) on platforms
- **Trainside:**
  - Some types of radio's have problems, others not
  - Suppliers are asked to inform Users about robustness improvements
  - Usage of filtering on trains and in Platform-Displays is in Pilot – is temporary workaround, not strategy

# Country case – UK, UMTS900

- > UK frequency regulator, Ofcom, liberalised the 900 band for UMTS usage in January 2011, and imposed a temporary co-ordination procedure on UMTS900 usage to protect “operational” GSM-R.
- > Ofcom co-ordination procedure is in-line with EU Report 96 and an independent study carried-out for Network Rail by ATDI, but offers no protection for GSM-R where it is not in operational service at time of UMTS900 deployment.
- > During March and April, Network Rail will participate in Ofcom lab testing on blocking and out of band emissions from UMTS 900 BTS into Kapsch, Sagem and Selex GSM-R mobiles. Network Rail seeking Ofcom’s consent to circulate results.
- > It is expected that these tests will produce a “Network Rail Boundary fence” level of an acceptable UMTS 900 signal strength.
- > Network Rail also considering conducting own tests for UMTS900 handset impact on GSM-R BTS in locations where many handsets may congregate eg large stations.
- > Network Rail have become aware that both UK 900MHz operators (O2/Telefónica and Vodafone) deployed trial UMTS900 sites in the UK in 2010 under Ofcom test licenses that were not advised or coordinated.
- > Chief Executive and UK government department dialogue continues as to whether Ofcom’s UMTS900 co-ordination procedure should protect all GSM-R sites, especially as Network Rail’s 200MHz analogue channels must be relinquished in 2012 to allow roll-out of continental Europe TV and radio digital broadcasting.
- > There appears to be a direct parallel in UK Government (transport vs telecoms) with conflicting instructions from EU Transport and Communications Directorates.

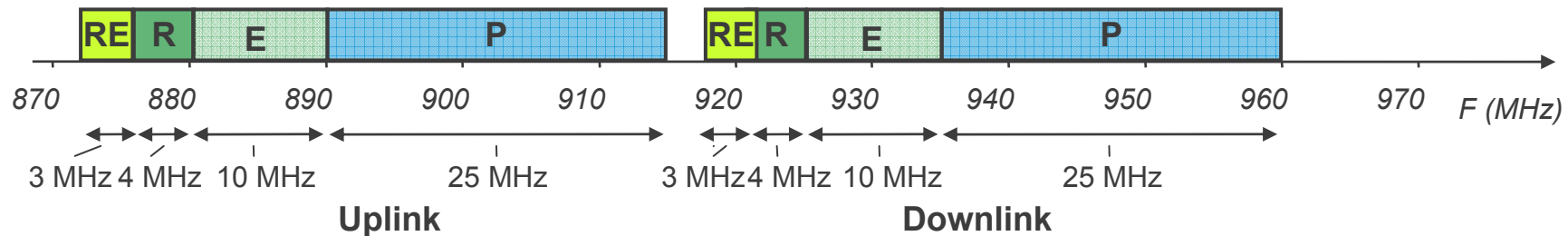
# GSM-R Frequency allocation situation

# GSM-R frequency spectrum

- In EU, GSM-R has a dedicated frequency allocated, outside GSM spectrum.
- 3 MHz are possible to be used, in the so called RE (Railway Extended Band)

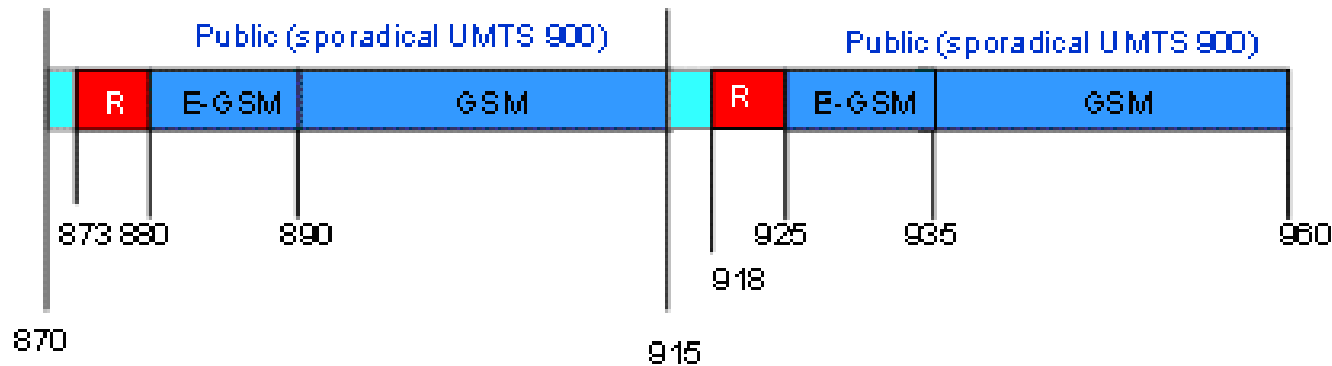
## GSM/GSM-R frequencies in the 900 MHz band

*P: Public GSM, E: Extended GSM, R: Railway GSM-R, RE: GSM-R Extended Band*



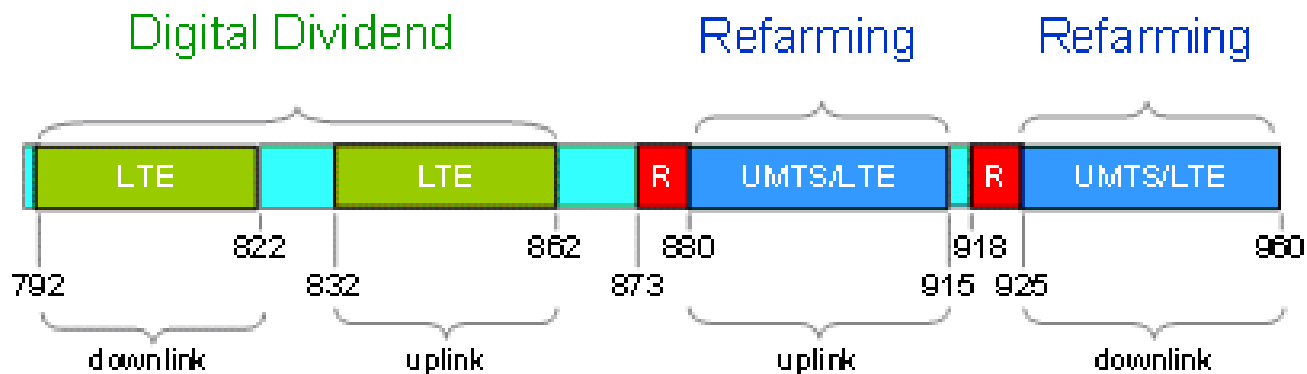
# Frequency situation shows the sandwich position of GSM-R between the frequencies of public mobile networks

## Existing situation



Unassigned spectrum  
(guard bands)

## Future conditions (reduced scale)



GSM-R Interferences – 23 of March 2011

Interference threshold exceeded

GSM NWS Transmitter Scan View											
CH	POWER	BSIC	CI	LAC	MNC	MCC	T(MEAS)	T(TDMA)	FN	T3	
1008	-28.56	75	4096	10401	7	262	2183828 ms	7.365	2361629	23	
991	-29.68	31	65522	852	3	262	2183556 ms	7.713	2578193	41	
984	-46.88	31	65512	852	3	262	2183459 ms	7.713	2578193	41	
1006	-48.88	73	24096	10401	7	262	2183828 ms	7.365	2361629	23	
1023	-50.64	73	44096	10401	7	262	2183071 ms	7.365	2361629	23	
1003	-53.84						2178540 ms	3.346			
977	-67.20	33	72	852	3	262	2183459 ms	7.713	2578193	41	
1022	-76.88	70	24240	10401	7	262	2179639 ms	5.628	481932	33	
996	-78.14	30	932	852	3	262	2183704 ms	0.939	2337817	28	
971	-79.04	71	122	1002	10	262	2183336 ms	2.380	1370050	37	
1009	-80.88	71	4096	10404	7	262	2171778 ms	3.713	519447	12	
1001	-80.72	(15)					2164736 ms	5.362	(311985)	(18)	
981	-82.32	37	58019	852	3	262	2183495 ms	5.944	607392	33	
1012	-83.60						2154563 ms	7.831			
1001	-84.72	70	44240	10401	7	262	2183684 ms	5.628	481932	33	
997	-86.56	33	57999	852	3	262	2183684 ms	5.947	607392	33	
962	-90.16	72	540							48	
1001	-90.64	75	4219							18	
993	-91.84	30	472	28812	3	262	2182898 ms	3.337	317882	44	
1013	-92.32	75	24135	10401	7	262	2183786 ms	6.950	351411	21	
997	-92.72	35	882	432	3	262	2127748 ms	3.946	617523	15	
986	-92.72	34	4042	852	3	262	2183545 ms	5.404	481891	43	
1010	-92.80	71	49479	10401	7	262	2183818 ms	6.839	931162	4	
978	-92.96	34	54809	852	3	262	2183455 ms	0.741	314303	41	
978	-93.04	30	11019	432	3	262	2179174 ms	7.943			
1002	-93.60	72	9028	10404	7	262	2179380 ms	4.199	1		
974	-93.84	31	65522	852	3	262	2175555 ms	7.712	2		
983	-93.92	34	54769	852	3	262	2174844 ms	0.740			
1014	-94.40	74	24263	10401	7	262	2183819 ms	0.013	2		
986	-95.04						2163744 ms	7.264			
1002	-95.20	(75)	(44270)	(10401)	(7)	(262)	2183704 ms	1.432			
1019	-95.36	77	4216	10401	7	262	2182210 ms	2.246	2		
1002	-95.60	74	44266	10401	7	262	2150987 ms	5.783	2362155	39	
987	-95.68	34					2182722 ms	2.500	98100	27	
1015	-95.76	70	29866	10401	7	262	2183074 ms	4.649	2241370	22	
											dBm

Sum of all interfering signals is causing problems

good GSM-R coverage

Interference threshold from Report 162