Using impact assessment to assess the case for revised spectrum allocation for Automotive Short Range Radar (SRR)

A training exercise for the ECO

Ken Pearson
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Plum Consulting 17-19 Bedford Street, Covent Garden, London, WC2E 9HP
T +44 (0)20 7868 5340 **www.plumconsulting.co.uk**

Disclaimer

The information provided in this presentation was prepared for the purposes of a training session to ECO members on the methodologies that can be applied for quantifying the impacts of regulatory decisions in spectrum management.

Sample data and calculation results are presented to illustrate the nature of calculations and provide practical experience for attendees. These examples are not intended to contribute to study work being undertaken by ECO and should not be taken as such.

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Agenda

- **Brief introduction from each of us:**
  - name, job, background, expectations of the day
- **Scope and form of the session**
- **Clarify regulatory options for evaluation**
- **The impact of each SRR option on stakeholders -** *group exercise*
- **Identifying, quantifying, and combining the economic costs and benefits**
- **Calculating the NPV of each SRR option -** *group exercise*
- **Key findings to report back to the plenary**

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The scope and form of the session

- **Definition of automotive SRR segments:**
  - Based as far as possible on work undertaken in FM47
  - Clarify options and framework for analysis
  - Aim to get appreciation of scale of impacts that could result in practice
- **The focus of our session**
  - Impact assessment ***rather than***
  - Detailed technical issues (such as precise capabilities of each technology) ***or***
  - Detailed refinement of assumptions
- **Two group exercises**
  - Divide into two/three groups
  - Work through the defined exercises
  - Report back and compare and discuss findings

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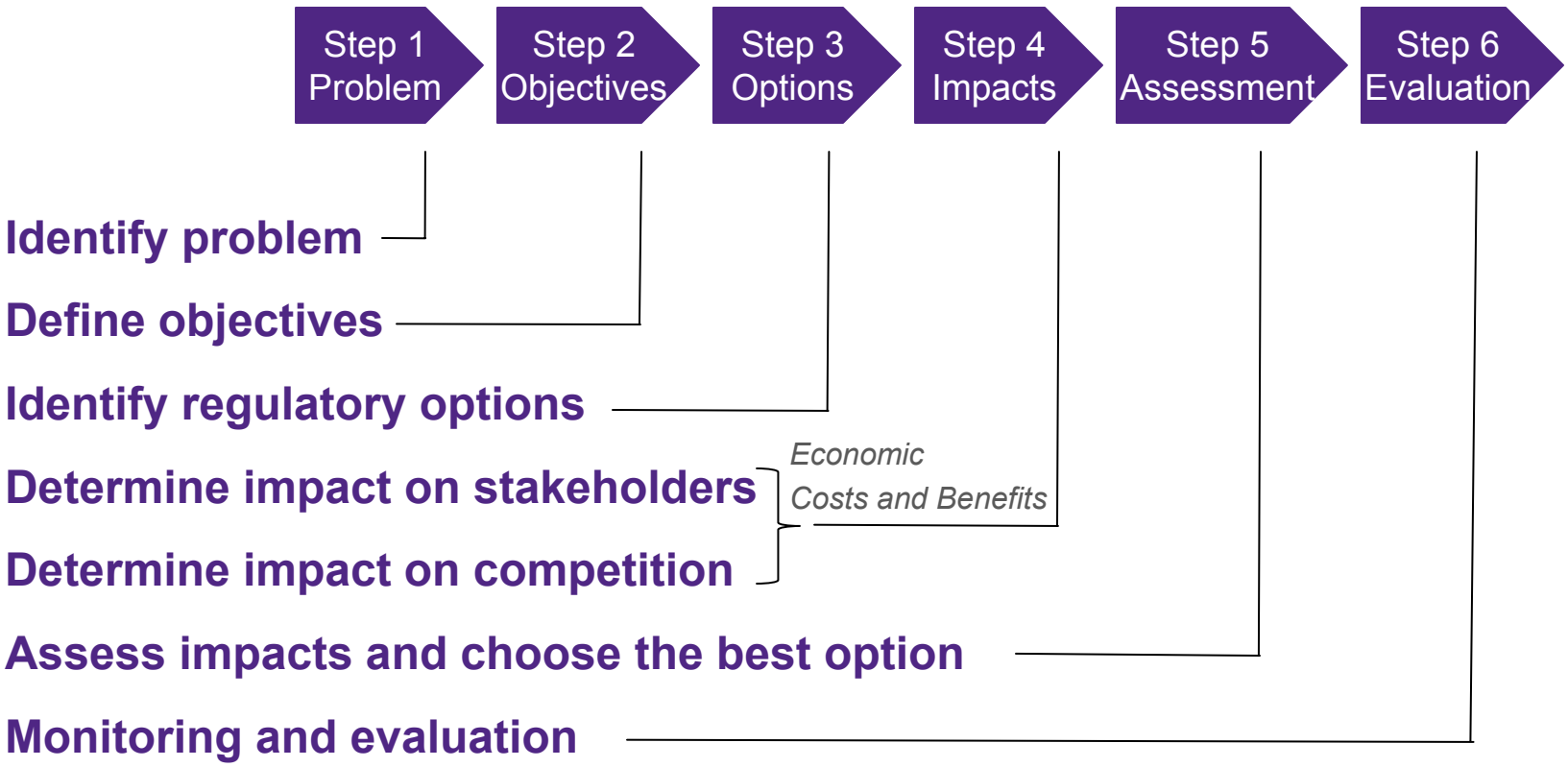
Proposed approach to impact assessment for SRR

- **Process in ECC report 125**



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Step 1. Identify the problem

- **Based on actual study work in FM47**
- **Currently 21.65 to 26.65 GHz is being used for SRR until 1st July 2013 cut-off**
- **EC Mandate to reconsider spectrum allocation in range 24-29 GHz**

Option	Frequency range	Main issue
1 (default)	77 to 81 GHz	Risk of not being able to fit SRR into new vehicles for a period following cut-off
2	24 to 29 GHz	Risk of interference to fixed networks
3	24.05 to 24.5 GHz and 77 to 81 GHz	Some features retained following cut-off, but risk of delay for full safety features

- **Which of the three options delivers the best outcome for Europe?**

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Step 2. Define objectives

What are your objectives in deciding whether to change spectrum allocations?

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What are your objectives?

- **Possible objectives**
  - Shorten time to market for products
  - Minimise end user price of products
  - Maximise safety benefits
  - Minimise interference impacts on licensed spectrum users
  - Maximise economic benefits
  - Some combination of all of these
- **From FM47 working paper FM47(09)038**
  - *"Achieving the safety benefits of collision mitigation and avoidance applications while minimizing the opportunity cost associated when designating spectrum."*
- **Possible perspectives**
  - National
  - European
  - Global

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Step 3. Develop regulatory options

What are the regulatory options for valuation?

- Three options defined so far in FM47 work
- When should the number of options be frozen?

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Characteristics of Option 1
(NB-24G and 77/79G only after 2013)

- **Up to 2013**
  - Products are fitted to some new cars based on SRR 24G technology
  - Safety benefits are obtained over this period for a small population of road users (primarily high end vehicles)
- **Beyond 2013**
  - NB-24G products still permitted (24.05 to 24.25 GHz)
  - NB-77G products should be available in vehicles (76-77 GHz)
  - Most OEM and car manufacturers expected to concentrate product development on:
    - 76-77 GHz LRR (NB-77G) and
    - 77-81 GHz SRR (79G)
  - Although 79G products are developed by 2013, they are not fitted within vehicles for a “few years” (assume 2016 for the purposes of this workshop)
- **Will NB-24G products be produced once NB-77G products available?**

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Characteristics of Option 2
26G and 77/79G (includes NB-24G WLAM)

- **Up to 2013 as for Option 1**
- **Beyond 2013**
  - Products are spread across NB-24G, 26G, NB-77G and 79G
    - Some OEM and car manufacturers concentrate on NB-24G and 26G products, delaying development of NB-77G and 79G
    - Other OEM and car manufacturers develop NB-77G and 79G products
  - Although 79G products are developed by 2013, they are not fitted within vehicles for a few years (assume 2016 for this workshop)
  - NB-24G and 26G products are fitted between 2013 and 2016 (with some reduction in effectiveness for safety features)
- **Will new products be based on NB-24G and 26G after 2016?**
- **Interference is expected for fixed link users at 26/28 GHz**

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Characteristics of Option 3
(NB-24G WLAM and 79G after 2013)

- **Up to 2013 as for Option 1**
- **Beyond 2013**
  - Same as Option 2 except that:
  - Wideband Low Activity Mode is available 24.05 to 24.5 GHz
  - Products are spread across fewer technologies i.e. NB-24G, NB-77G and 79G
  - NB-24G products are fitted between 2013 and 2016 (with some reduction in capability for safety features
- **Will new products be based on NB-24G and NB-24G WLAM after 2016?**

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Safety capabilities of each option

- **FM47 has sought to establish the capability differences for each of the options**
  - A questionnaire was issued to stakeholders asking about the capability of each technology
  - A summary of reported capability was prepared: FM47(09)051
  - This summary was not approved by members of FM47
- **Although there is not consensus on the capability under each option we can assume (for this training day) that:**

Option	Strengths / weaknesses	Safety capability
1	Some safety capability will continue to be available in cars between 2013 and 2016 due to availability of NB-24G and NB-77G radars	+
2	Better safety features will be available between 2013 and 2016 than Option 1. However power restrictions on 26G will mean reduced capability compared to 79G when it becomes available.	+++
3	Better safety features will be available between 2013 and 2016 than Option 1. However the narrower bandwidth compared to 26G will reduce its ability to discriminate objects.	++

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Summary of regulatory options

- *Option 1*: **do nothing and let current allocations for SRR stand**
- *Option 2*: **allocate 24 to 29 GHz for SRR**
- *Option 3*: **allocate 24.05 to 24.5 GHz**
- *Option 4:* **?**

- **Other questions**
  - Could 26G allocation cease in 2016?
  - Can the current arrangements be extended?
  - Is there flexibility in emission limits?
  - Can some aspects be made discretionary at national level?
  - Can the decision be delayed?

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Step 4. Determine impacts

- **Q1: Which are the main categories of stakeholders affected by the allocation changes?**

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The main categories of stakeholders

- **From responses to the SRR questionnaire**
  - Car manufacturers
  - OEM producers
  - Regulatory authorities
  - Amateur radio users
  - Public Safety Communications
- **Other stakeholders**
  - Fixed link users
  - Public Fixed Wireless Access operators
  - Road users
  - Car owners
  - Car dealers and car servicing
  - Test and measurement facilities
- **Any others?**

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Identifying impacts

- **Q2: What are the main impacts of the allocation changes on each of them? Are they costs or benefits and who bears them?**

- **Group exercise for Q2**
  - Each group consider a different option
  - Priority to capture all impacts
  - Consider nature of impact on stakeholders
  - Consider whether a cost or benefit
  - Choose somebody to report findings

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The main impacts of SRR options

Option	Impact
1	Enhanced road safety leading to reduced accident rates
	Delayed implementation in new cars for a period after 2013 (how long?)
	Consolidated sales volume in 76 to 81 GHz band
2	Enhanced road safety leading to reduced accident rates
	Maintained implementation after 2013 but at slightly reduced effectiveness in safety applications due to emission constraints
	Fragmented sales volume due to products split between 26G and 79G technology
	Harmonisation with USA leading to greater product volume
	Retention of the value of investments already made in 24G product development and production
	Interference in 26/28 GHz fixed networks
3	Enhanced road safety leading to reduced accident rates
	Maintained implementation after 2013 but at slightly reduced effectiveness in safety applications due to narrower bandwidth
	Fragmented sales volume due to products split between 24G-NB (WLAM) and 79G technology
	Some harmonisation of frequency bands leading to greater product volumes
	Retention of the value of investments already made in 24G product development

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Potential impacts

Type of impact	Potential economic effects
Enhanced road safety leading to reduced accident rates	Savings in costs of personal injury and death Savings in costs of vehicle damage Reduced traffic congestion leading to savings in journey times or expenditure on road infrastructure
Delayed implementation in new cars for a period after 2013	Reduction in potential road safety benefits for (3?) years
Maintained implementation after 2013 but at slightly reduced effectiveness in safety applications	Some reduction in potential road safety benefits for (3?) years
Consolidated sales volume in 76 to 81 GHz band	Lower product prices leading greater product take-up More competition leading to greater innovation and higher consumer willingness to pay
Fragmented sales volume due to products split between 24G / 26G and 79G technology	Higher product prices leading to lower product take-up Weaker competition leading to less innovation and lower consumer willingness to pay
Harmonised frequency ranges with the USA leading to higher product volumes	Lower product prices leading greater product take-up More competition leading to greater innovation and higher consumer willingness to pay
Retention of the value of investments already made in 24G product development and production	The value of investments already made in 24G development Savings in future development costs for manufacturers that have already developed products based on 24G
Interference in 26/28 GHz fixed networks	Cost of alternative fixed link solutions for cellular operators (current and future sites affected by high traffic congestion) Cost of additional sites for FWA operators to increase C/I ratios in affected areas

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Step 5. Quantifying the costs and benefits

- Which of the impacts are true economic costs or benefits?
- Which ones are hard to quantify and how might we do it?

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The economic costs and benefits - theory

- **A cost or benefit for a given stakeholder is not always an economic cost or benefit**
- **In particular impacts which transfer costs or revenues from one stakeholder to another should not be counted**
- **To deal with such difficulties CBAs:**
  - Examine the extent to which each option increases *economic surplus...*
  - ...relative to a *counterfactual*
- **Defining a counterfactual, and then estimating the incremental economic costs and benefits of each option relative to it, is central to a CBA**

- ***What should be the counterfactual?***

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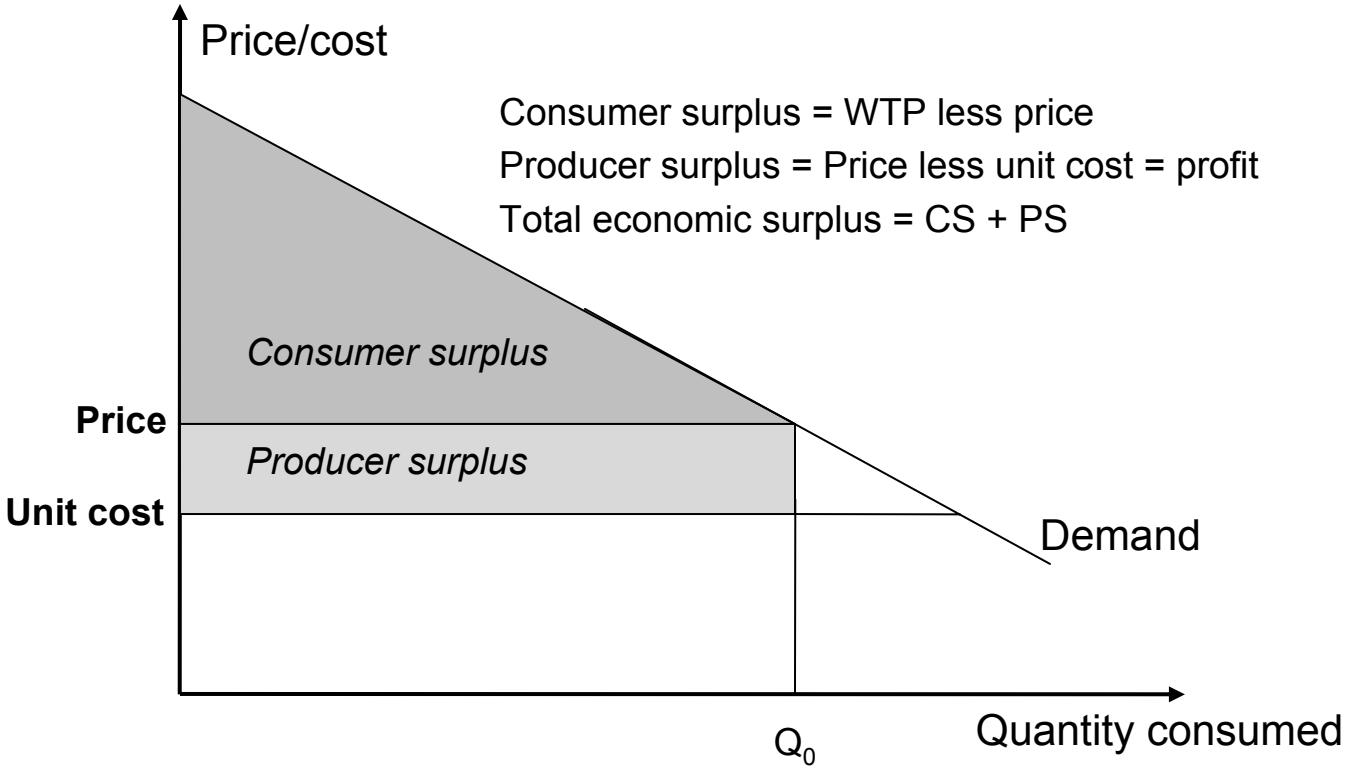
Economic surplus



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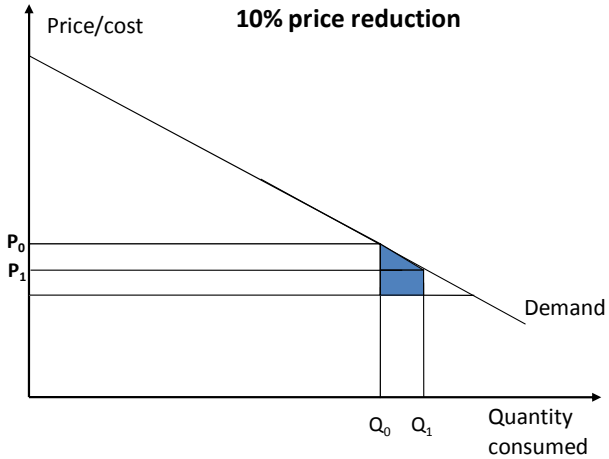
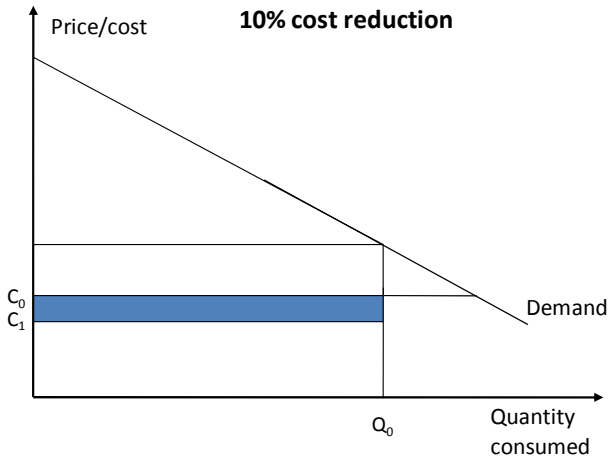
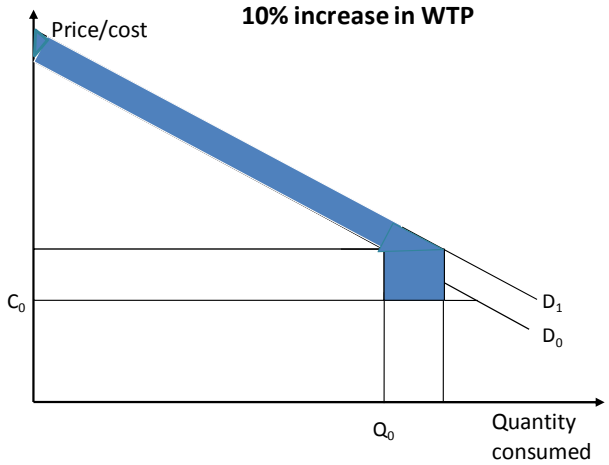
Incremental (costs and) benefits







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Summary of major costs and benefits

Type of impact	Cost/benefit relative to the counterfactual	
	Option 2	Option 3
Fragmented sales volume	Cost to 79G manufacturers and consumers - higher prices and lower take-up of 79G technology in the short/medium term	Cost to 79G manufacturers and consumers - higher prices and lower take-up of 79G technology in the short/medium term
Harmonised frequency ranges with the USA	Benefit to 26G producers and consumers – lower prices and higher take-up of 26G technology	Benefit to WLAM producers and consumers – lower prices and higher take-up of NB-24G WLAM technology
Interference in 26/28 GHz fixed links	Cost to fixed link operators – cost of alternative equipment for affected links, both current and anticipated links	
Enhanced road safety	Benefit for all road users - savings arising from earlier penetration of safety enhancing devices. Saving arising from reduction in personal injury, deaths and vehicle damage	Benefit for all road users – as for Option 2 but to a lesser extent

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How to combine one off and ongoing benefits - 1?

- **Is the project with the net benefits stream shown worth implementing?**
- **General approach to this problem:**
  - Express all costs and benefits at constant prices (equivalent to zero inflation)
  - Discount future net benefits
  - Calculate termination value for net benefit stream
  - Sum the discounted net benefits to get the net present value or NPV

Year	*Net benefit*
1	-100
2	5
3	10
4	15
5	15
6	15
7	15
8…	15…

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How to combine one off and ongoing benefits - 2?

- **Discounting future net benefits - assuming zero inflation, would you prefer:**
  - £100 now or £100 in one year's time?
  - £95 now or £100 in one years time?
  - £90 now or £100 in one year's time?
- **Options for dealing with termination values:**
  - Assume zero at end of project
  - Assume a positive value based on net benefit in final year continuing to infinity - but discounted at a high rate to reflect uncertainties
- **Worked example (based on discount rate of 5%):**

Year	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	
Net benefits	-100	5	10	15	15	15	15	15	
Discount factor	1	0.95	0.91	0.86	0.82	0.78	0.75	0.71	0.68
Termination value (TV)									60
Discounted net benefit	-100	5	9	13	12	12	11	11	41
NPV with TV	13								
NPV without TV	-27								

- **Public policy discount rates tend to be lower than commercial rates**

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Dealing with impacts which are difficult to quantify

- **How do you quantify:**
  - The impact on other licensed users of 26/28 GHz spectrum?
  - The safety benefits of SRR?
  - The impact of price changes?
- **How should you deal with the uncertainty in your estimates?**
  - Sensitivity analysis – a reasonable range on inputs
  - Test values – what levels are significant

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Group exercise 2

- **What is the NPV of spectrum allocation for each option given the assumptions set out in next slides?**
- **Consider two impacts:**
  - Group 1
    - Impact of interference on 26/28 GHz fixed services
  - Group 2
    - Impact of differing capability levels on safety benefits
- **Consider the structure of the problem**
  - What data is required to quantity the impact
  - How to perform the calculations
  - Form an initial estimate of cost/benefit

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Assessment of interference on FS (example based on fixed links)

- **Assume each affected link must be replaced with 2 links at 38 GHz**
- **Consider both current and new links implemented over next 10 years (assuming linear growth)**

Assumption	Value
Number of links in 26/28 GHz bands in Europe in 2013	85,000
Number of links in 26/28 GHz bands in Europe in 2023	170,000
Proportion of links affected under Option 2	0.1%
Capital cost per 26/28 GHz link	€25k
Capital cost per 38 GHz link	€20k
Equipment lifetime	10 years
Annual maintenance cost (as % of capital cost)	12%
Discount rate	4%
Note that the data in this table is not validated and for sample calculation purposes only	

- **What is the Net Present Value (NPV) of this cost under Option 2?**
- **Which parameters should be checked for sensitivity?**

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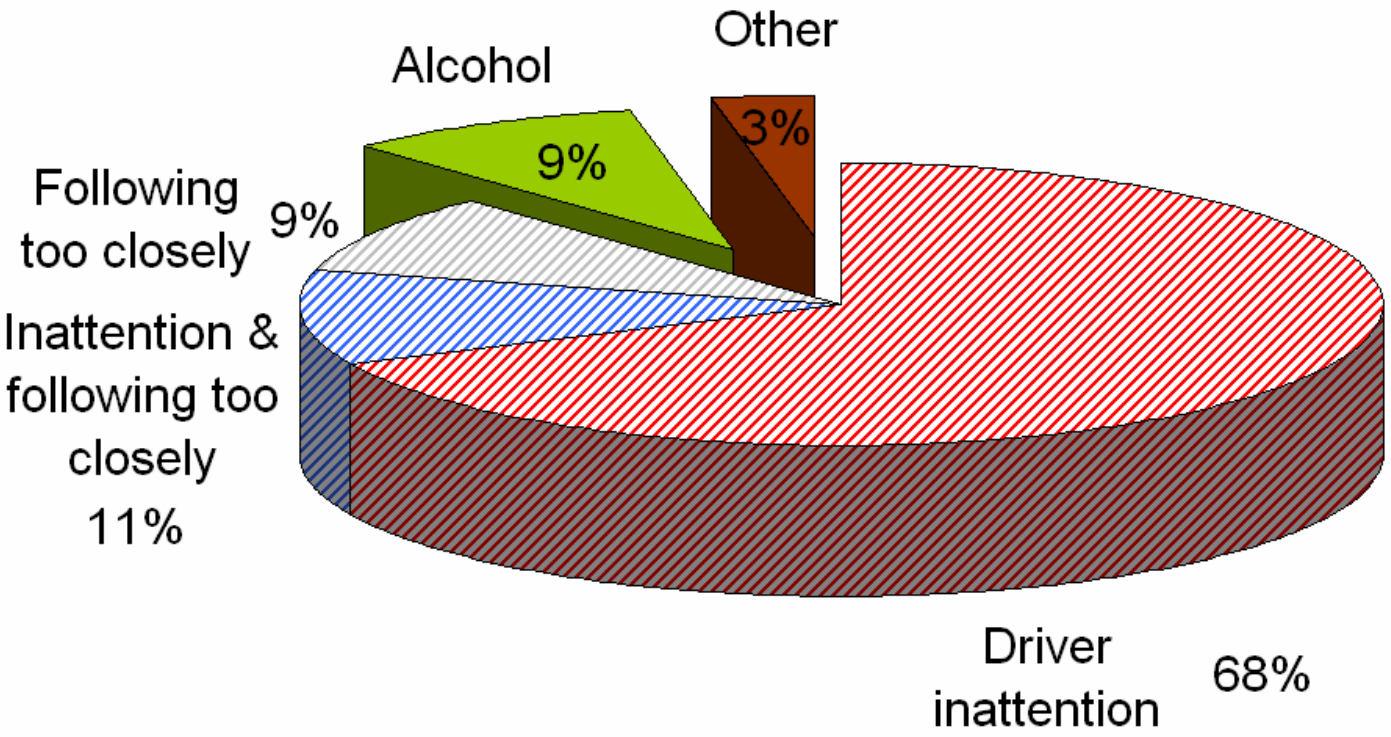
Causes of rear/front crashes



Source: ETSI TR 102 263 V1.1.2 (2004-02)

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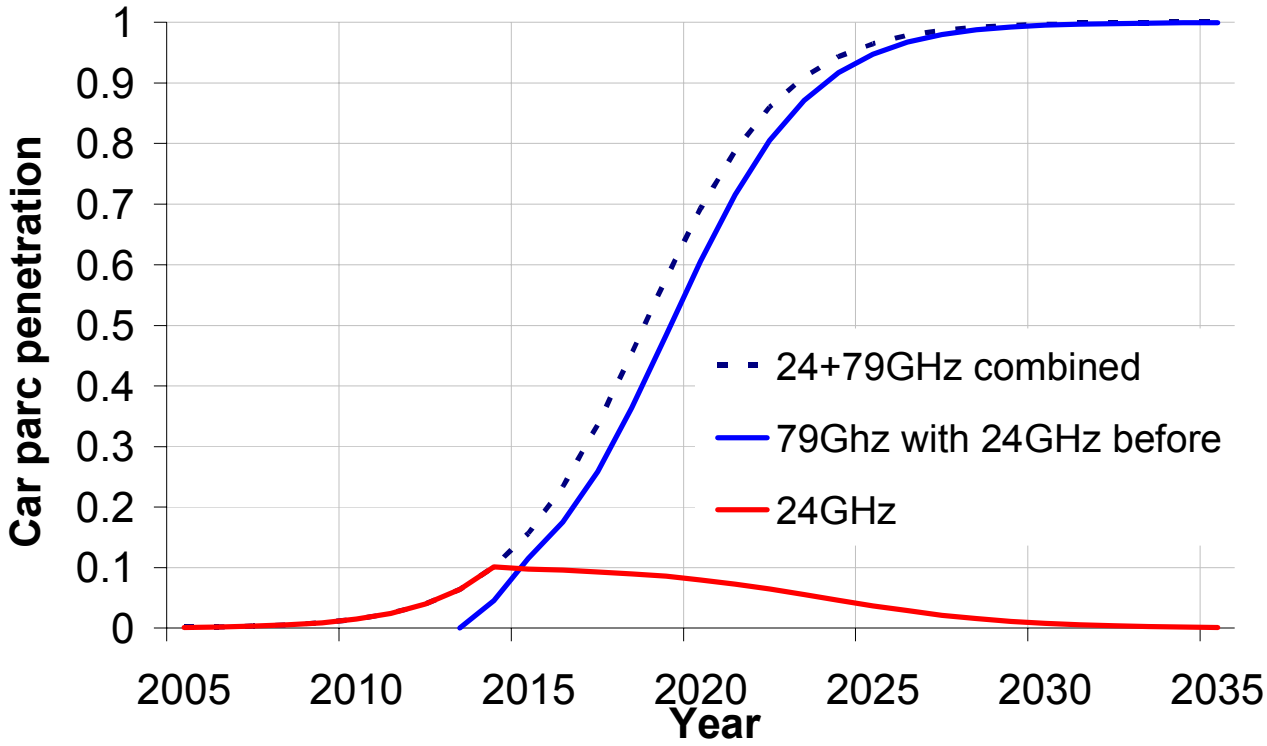
Anticipated take-up of SRR

- As forecast in 2004



Source: ETSI TR 102 263 V1.1.2 (2004-02)

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Impact on safety benefits

- **Other useful data**
  - UK Department for Transport estimates value per accident of £88,000 (weighted average of death, serious injury and vehicle damage), approximately equal to €100,000
    (source: Highway Economics Note No.1: 2005 Valuation of the Benefits of Prevention of Road Accidents and Casualties
    *www.dft.gov.uk/pgr/**road**safety/ea/pdfeconnote105.pdf*)
  - There were 1.4 million road traffic accidents in EU27 countries in 2005
    (source: www.unece.org/trans/main/wp6/transstatpub.html)
  - Total car population in EU27 is approximately 270 million
    (source: www.prnewswire.com/mnr/volvo/37521/docs/37521-Safety_Belt_Statistics_Eng.doc)
  - Assume current installation price for SRR is €50 per car
- **What is likely to happen to the take-up curve under each option?**
- **How should total benefits from safety be calculated?**
- **What data or parameters would improve the calculation?**

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Distributional effects can be important

- **The economically efficient option is the one offering the biggest increase in total economic surplus**
- **But this option might not be acceptable socially and politically if one group of stakeholders loses out too much**
- **So we need to consider:**
  - The impact of the best option on each major group of stakeholders
  - Whether any stakeholder loses out to an unacceptable degree
  - Whether there are other policy instruments (eg tax breaks, direct subsidy) which can reduce such problems to acceptable levels
- **Are there any big distributional impacts which might effect a decision on whether or not to re-allocate spectrum for SRR?**

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The distribution of the benefits of re-allocating spectrum SRR

- **Ratio of high/medium/low end vehicles**
  - Variation in safety benefits for each country
- **Implementation of fixed networks at 26/28 GHz**
  - Countries have differing levels of fixed network deployment
- **Are these significant?**

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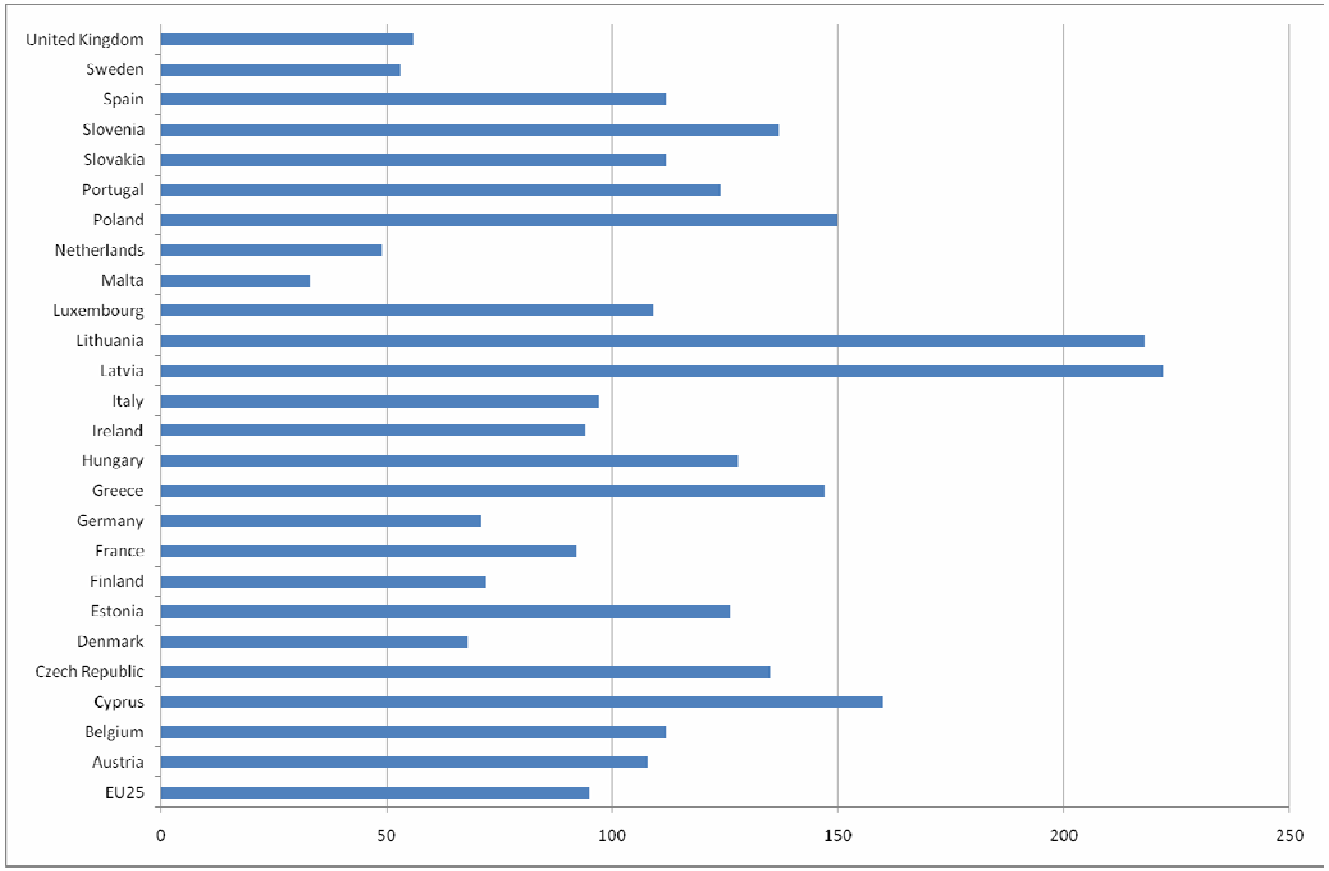
Variation in accident death rates in 2006 (EU25)



Road deaths per 1M inhabitants

Source: http://europa.eu/rapid/pressReleasesAction.do?reference=STAT/06/125

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Questions for discussion

- Which option should be chosen based on evidence available in this session?
- Why/why not?

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Evaluation

- What should be monitored between now and 2013?
- What options should be retained to revise policy? If any?

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Major findings

- What major points should we report back to the plenary session this afternoon?
- Who will do it?

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