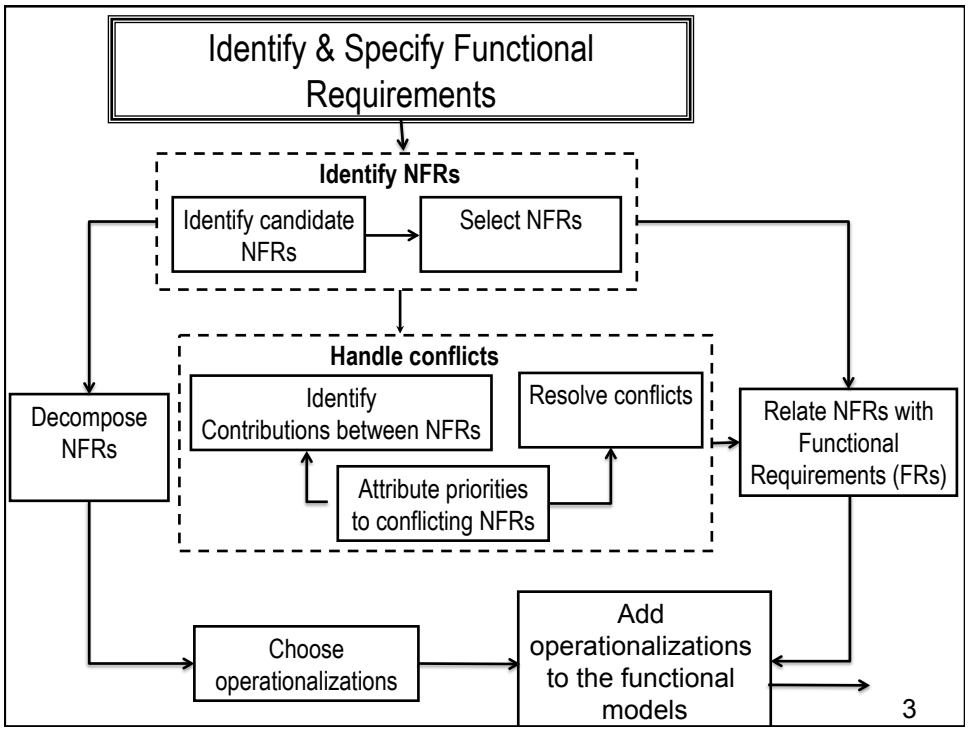
NFRs in the context of MDS

Based on the work on Aspect-Oriented Requirements Analysis with Viewpoints by [Rashid, Moreira, Araujo, 2003]

Reason about NFRs in MDS

- Identify and specify functional requirements
  - (We used UML)
- Identify candidate NFRs and Select NFRs based on importance
  - Identify based on documentation, project family, catalogues
- Relate functional and non-functional requirements
  - Use cases, classes, components
- Handle Conflicts between NFRs and their impact on functional requirements
  - Identify contributions (Negative, Positive), Allocate priorities, Resolve conflicts
- Decompose NFRs
- Select operationalizations
  - Project the impact of this selection into the functional models


Identify & Specify Functional Requirements
Identify NFRs
Identify candidate NFRs
Select NFRs
Handle conflicts
Identify Contributions between NFRs
Resolve conflicts
Attribute priorities to conflicting NFRs
Decompose NFRs
Relate NFRs with Functional Requirements (FRs)
Choose operationalizations
Add operationalizations to the functional models
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Toll Collection System: Authorised Vehicle
Euro 20
Toll Gate
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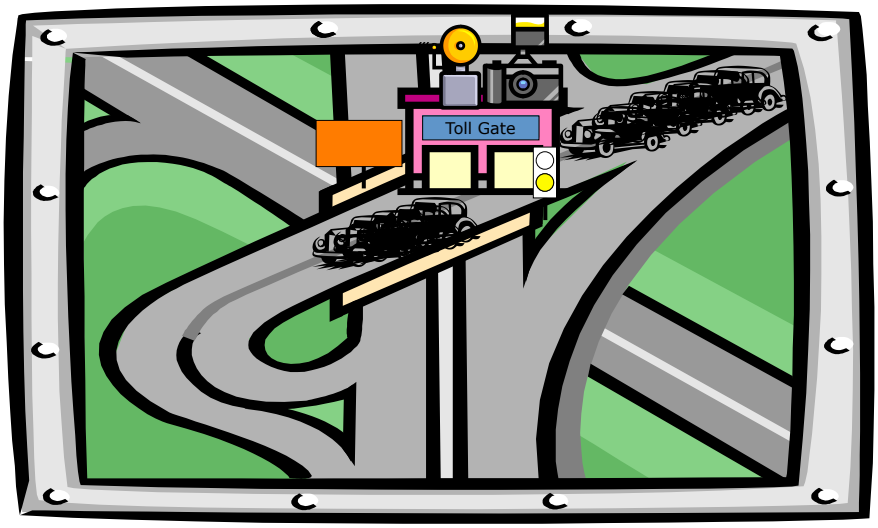
Toll Collection System: Unauthorised Vehicle



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Via Verde (original)

- In Via Verde, drivers of authorized vehicles are charged at toll gates automatically. For that, a driver installs a device (a gizmo) in his vehicle. The registration of authorized vehicles includes the owner's personal data and account number (from where debits are done monthly), and vehicle details.
- A gizmo has an identifier that is read by toll gate sensors. The data read by the sensor is stored by the system and used to debit the respective account. The amount to be debited depends on the kind of the vehicle.
- When an authorized vehicle passes through a green lane, a green light is turned on and the amount being debited is displayed, before the vehicle leaves the toll gate area, so that the driver can see that information. If an unauthorized vehicle passes through it, a yellow light is turned on and a camera takes a photo of the plate (that will be used to fine the owner of the vehicle). This needs to be performed before the vehicle leaves the toll gate.
- There are green lanes where the same type of vehicle pays a fixed amount (e.g. at a toll bridge), and others where the amount depends on the type of the vehicle and the distance travelled (e.g., on a motorway).

Functional Requirements (FRs)

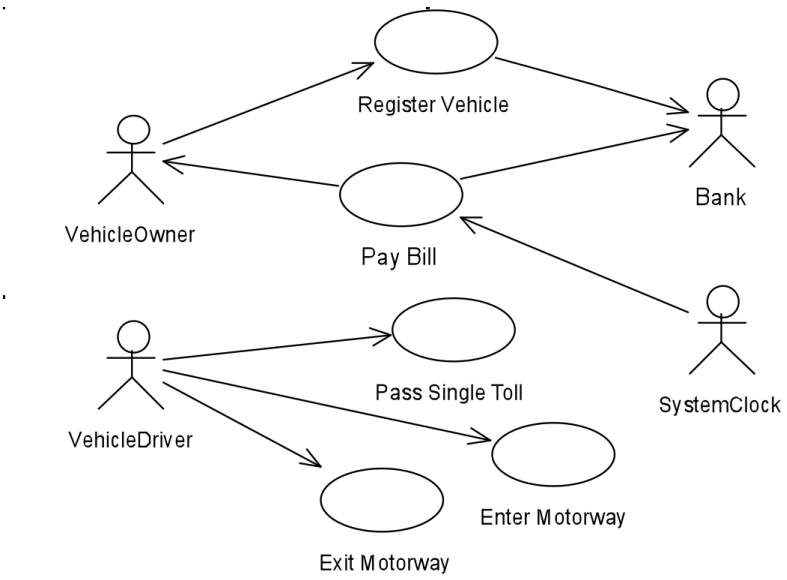
Actors:

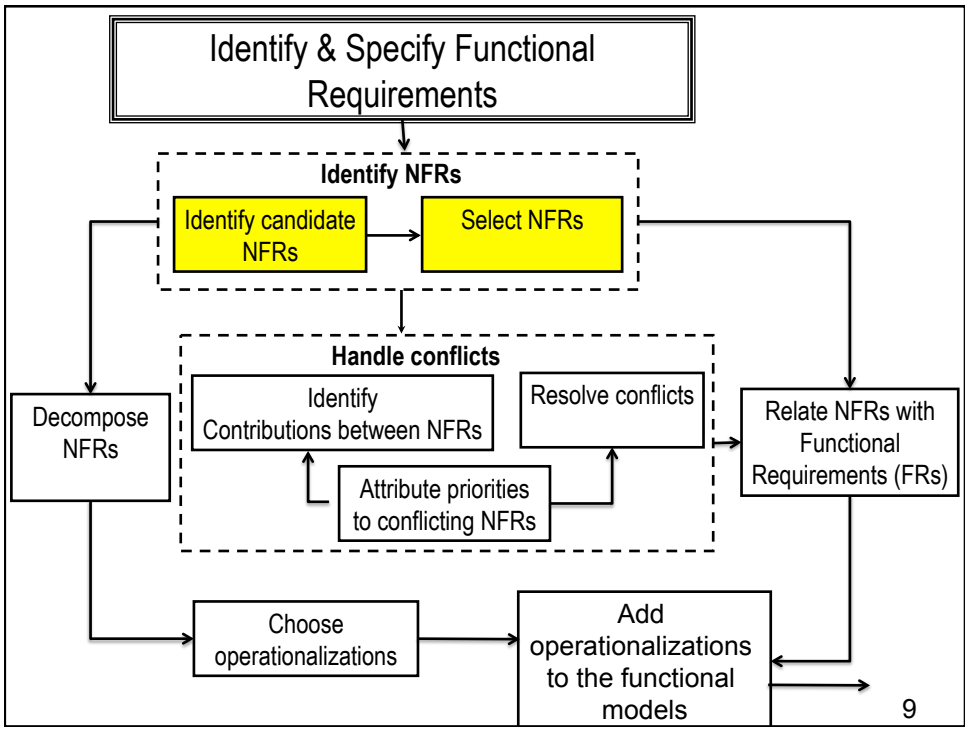
- Vehicle Owner
- Driver
- Bank
- (Police)

Use cases:

- Register driver
- Enter motorway
- Exit motorway
- Pass single toll
- Pay bill

Use case diagram





Identify candidate NFRs

- Security
  - of the vehicle owner data
- Response Time
  - Decomposition of performance
- Multi-Access
  - Many drivers simultaneously
- Compatibility
  - With Banking systems for debits (and ATM for gizmo activation)
- Legal Issues
  - Fine unauthorized drivers, …
- Correctness
  - Make sure the amount to be debited is the correct one
- Availability
  - System needs to be available with the with the exception of a total of 30 minutes every year (for maintenance).

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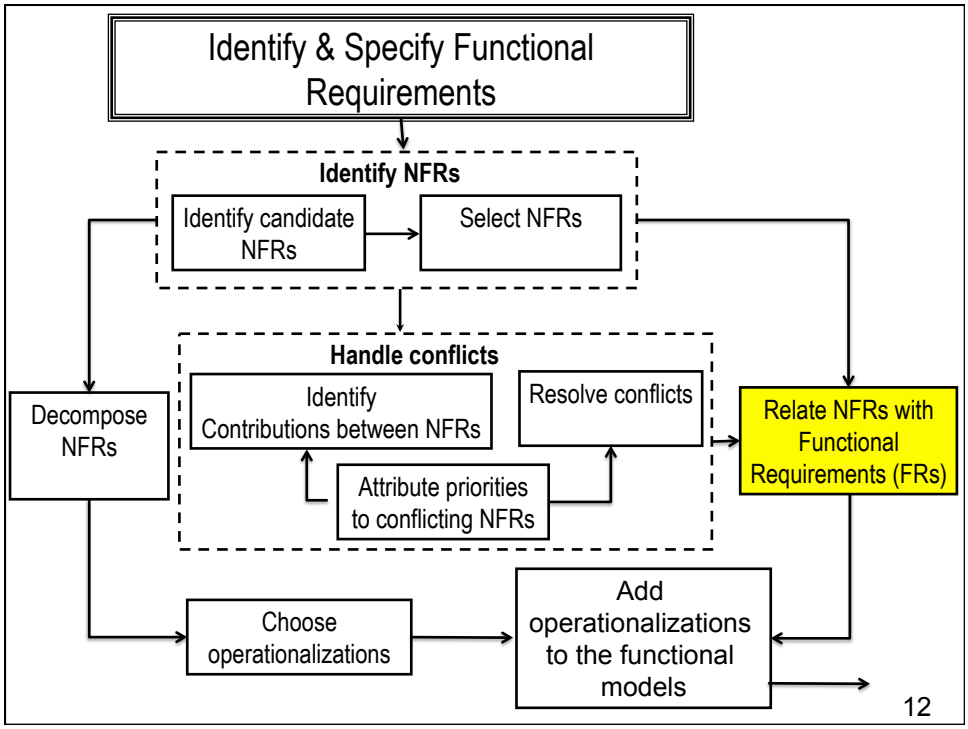
Select NFRs

- Security
  - of the vehicle owner data
- Response Time
  - Decomposition of performance
- Multi-Access
  - Many drivers simultaneously
- Availability
  - System needs to be available with the with the exception of a total of 30 minutes every year (for maintenance).



NFRs/Use Case Relationships

Without NFRs selection…

NFRs \ UseCases	RegisterDriver	EnterMotorway	ExitMotorway	PassSingleToll	PayBill
Response Time		x	x	x	
Availability		x	x	x	
Security	x				x
Legal Issues					
Compatibility					x
Correctness	x	x	x	x	x
Multi Access		x	x	x	

… let's reduce to the essential ones.

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NFRs/Use Case Relationships

NFRs \ UseCases	RegisterDriver	EnterMotorway	ExitMotorway	PassSingleToll	PayBill
Response Time		x	x	x	
Availability		x	x	x	
Security	x				x
Multi Access		x	x	x	

… we could reduce further…

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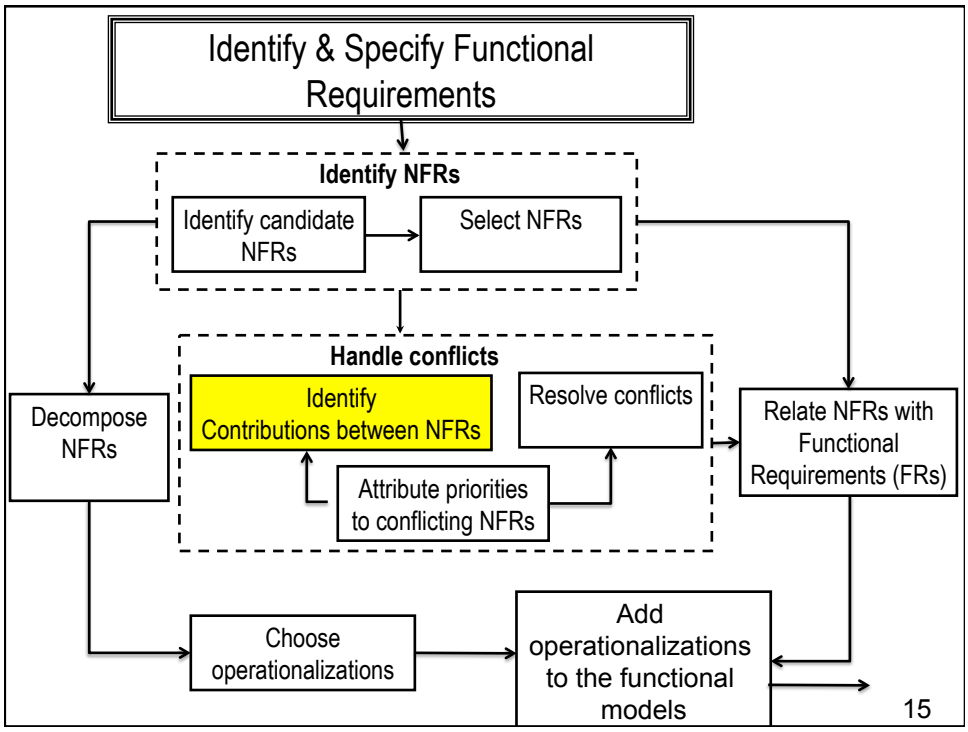

Identify contributions between NFRs

- Let´s build a contribution matrix…
  - Where each NFR may contribute negatively (-) or positively (+) to the others
    (empty cells represent “don’t care” contributions)

Without reduction first (only for the sake of exercising)…

NFRs \ NFRs	Resp.Time	Availability	Security	Legal Issues	Compatibility	Correctness	Multi-Access
Resp.Time		+	–			–	–
Availability							+
Security						+	
Legal Issues					+	+	
Compatibility							
Correctness							
Multi-Access							

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Identify contributions between NFRs

- Only for the chosen subset…

NFRs / NFRs	Resp.Time	Availability	Security	Multi-Access
Resp.Time		+	–	–
Availability				+
Security				
Multi-Access				

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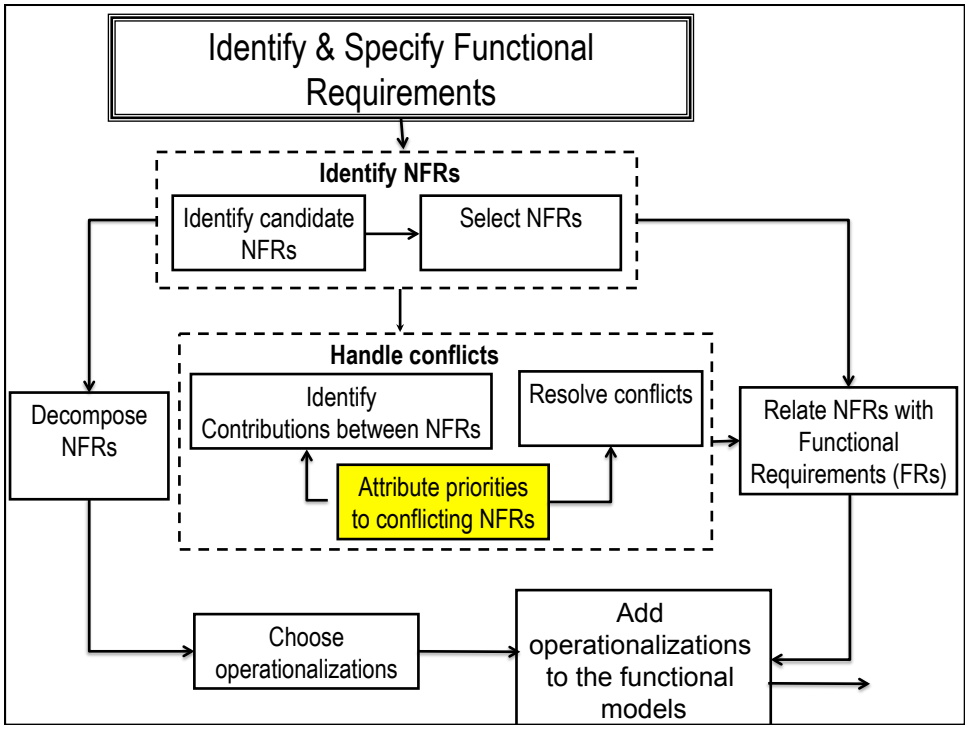

Trade-off Analysis (1)

- Basic question
  - How much must I give up to get a little more of what I want most?
- How can we define a good / better outcome?
  - Reduced time of response
  - Improved security access
  - Increase number of clients being served simultaneously

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Trade-off Analysis (2)

- Find the combination that better satisfies the stakeholder goals
- What can actually be done given reality and resource constraints?
  - Use sophisticated techniques such as MCDM, fuzzy logic, etc.
  - Use some simple way to achieve a ranking between conflicting concerns (with the stakeholders help)

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Attribute Priorities to Conflicting NFRs (1)

- Attributing weights to those aspects that contribute negatively to each other
- Priority of an aspect in relation to a set of stakeholders' requirements
- Extent to which an aspect may constrain another concern

Very important takes values in the interval]0,8 .. 1,0]

Important takes values in the interval]0,5 .. 0,8]

Average takes values in the interval]0,3 .. 0,5]

Not so important takes values in the interval]0,1 .. 0,3]

Do not care much takes values in the interval [0 .. 0,1]

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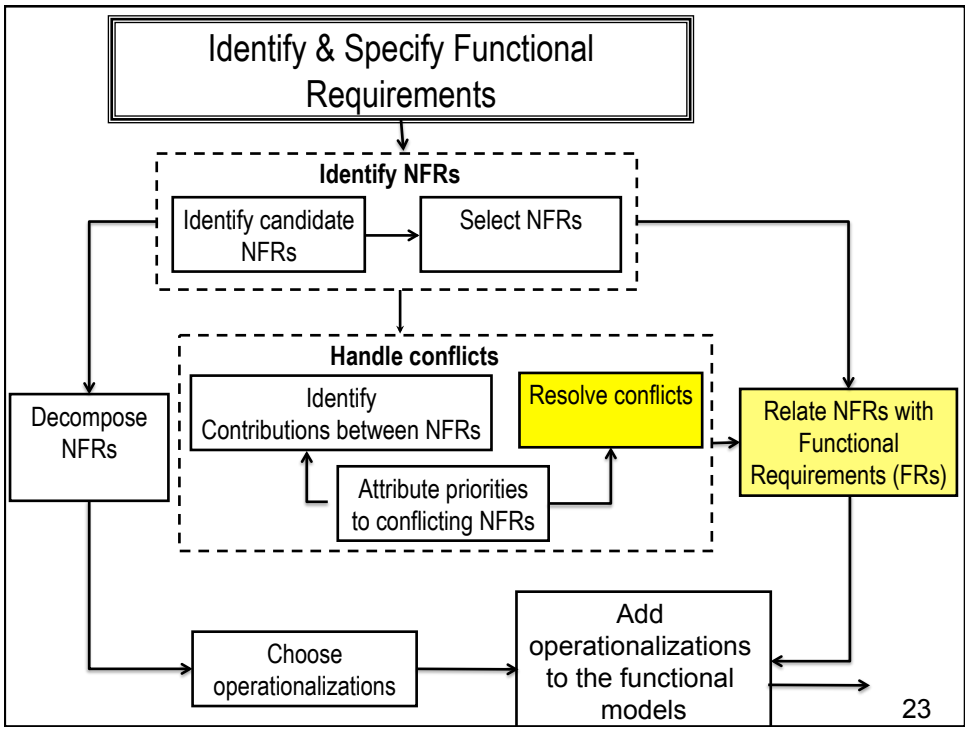
Allocate priorities

- The same NFR may have different priorities depending on:
  - the module it affects and also on the involved stakeholders for the different modules (we will ignore that)
- Allocate priorities to all, but especially to conflicting NFRs

UseCases / NFRs	RegisterDriver	EnterMotorway	ExitMotorway	PassSingleToll	PayBill
Response Time		Very Important	Very Important	Very Important	
Availability		x	x	x	
Security	x				x
Multi Access		Average	Average	Very Important	



Resolve conflicts

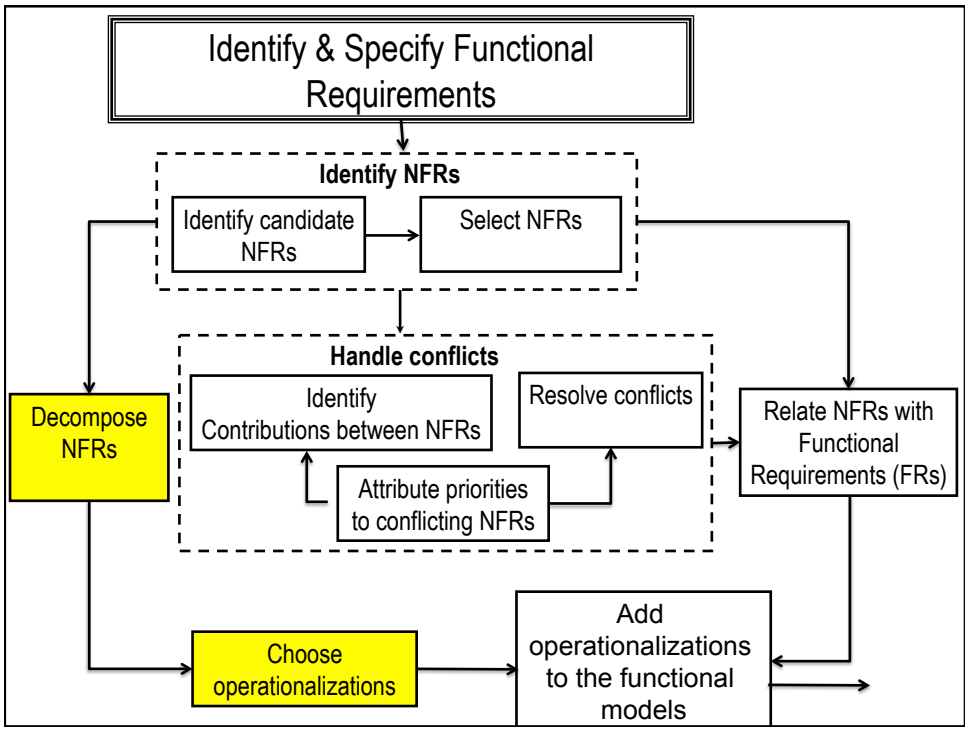
- Conflict resolution may require negotiation among stakeholders
- Whenever two or more NFRs with negative contribution affect the same concern (use case, class, or component…) we need to establish a ranking between them

React in time vs Multi-access

NFRs \ UseCases	RegisterDriver	EnterMotorway	ExitMotorway	PassSingleToll	PayBill
Response Time		1.0	1.0	1.0	
Availability		x	x	x	
Security	x				x
Multi Access		0.5	0.5	1.0	

Easy!

Need help!



Decompose NFRs and Choose Operationalizations

- Use the NFR Framework (from Chung et al.) corresponding tasks

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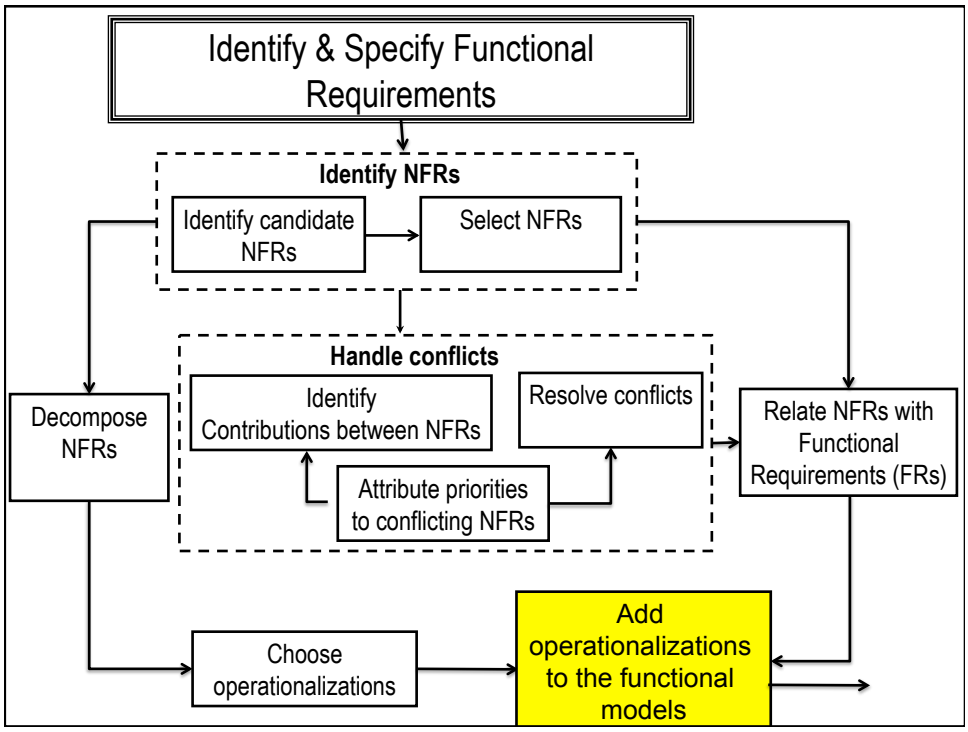

Project the impact on the functional models:
Add operationalizations to the functional models

- The operationalizations chosen should be added to the functional models, in particular to the class and component diagrams.
- For example, for the conflicting NFRs:
  - Security: you may add a new Security Component, which will be implement according to the chosen operationalization
  - Multi acess: (1) the subsystem handling the Toll Gates corresponding components should support concurrecy; (2) a decision regarding the number of physical toll gate sets needs to be discussed (probably more should be installed in single points than in motorways)
  - Remaing NFRs: need similar study

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Generalization of the process

- You may want to apply this process to classes, or components, for example
- This requires that in the NFR x FR table
  - the use cases are substituted by the appropriate module (component, for example)
  - study how the NFRs relate with the new modules (components, for example)