Managing Conflicting Resource-based Requirements in Systems of Systems

Conference or Workshop Item

How to cite:


For guidance on citations see FAQs.

© [not recorded]

Version: Version of Record

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online’s data policy on reuse of materials please consult the policies page.
Managing Conflicting Resource-based Requirements in Systems of Systems

Thiago Viana, Andrea Zisman and Arosha Bandara

Faculty of Science, Technology, Engineering and Mathematics
School of Computing & Communications
Adaptive Security and Privacy (ASAP) research programme

AWASE - 2017
Example of an SoS

Feed Me Feed Me (Bennaceur et al, 2016)
New System, Same Old Problem...

• **Conflicting requirements** - a common problem present in all types of systems.

• Conflicts will arise within each component system and also across the SoS as a whole due to unexpected interactions.
Resource-based Conflicting Requirements

- **Resources**
  - Calories;
  - Insulin;
  - Food;
  - Electricity;
  - Budget.

- **Focus on Requirements Satisfaction**
  - Relaxing requirements to manage conflicts.
• **AM_R5** - AnalyseMe SHALL suggest a `<meal plan>` with `<total calories>` AS CLOSE AS POSSIBLE TO `<ideal calories level>` AND `<total insulin>` AS CLOSE AS POSSIBLE TO `<ideal insulin>`.

• **HH_R2** - HomeHub SHALL `<prevent food consumption>` AS EARLY AS POSSIBLE AFTER `<food resource>` is AS CLOSE AS POSSIBLE TO `<20%>` of the `<total home food resource>`.
Conflict Identification

- **Assertions Monitor**
  - Violation detected in the Requirement $Re$ regarding the Resource $R$

Overlap Detection

- **Basic Search**
  - Assertions Engine Search
- **Inference Search**
  - Behavior Inference Engine Search

Conflicting Requirements Mapping

Conflict Diagnosis

- Requirements Interaction Features (Basis, Degree, Direction, Likelihood)

Conflict Resolution

- Utility Function
- Resolution Method List

ENTITIES (CSs, Webservices, SoSs)
• **HH_R2** - HomeHub SHALL `<prevent food consumption>` AS EARLY AS POSSIBLE AFTER `<food resource>` is AS CLOSE AS POSSIBLE TO `<20%>` of the `<total home food resource>`.

• **RELAX Grammar Expression**:  
  – **SHALL** (AS EARLY AS POSSIBLE AFTER `q p`)  
    • `q` is (AS CLOSE AS POSSIBLE TO `a b`)  
      – `a` is 20% x `<total home food resource>`  
      – `b` is `<food resource>`  
    • `p` is `<prevent food consumption>`

• **Formal FBTL expression**:  
  – `AGX>q p`  
  – `q = AF(Δ(b) – a ∈ S)`
• **Assertions Engine Search**
  • The assertions related to the same resource have overlapping elements, they might be:
    • Complementary (Disjoint), Mutually Exclusive, Subset, Cooperative, Opposite and Irrelevant;

• **Behavior Inference Search**
  • Inferences over the statechart and the RELAX requirement using ontology matching functions.
• The requirement related to the violated assertion;
  – HH_R2
    • As an example, consider requirement HH_R2 with the actual value for <food resource> as 16 and that 20% of <total home food resource> is 20.

• The requirements related with the overlapped assertions;
  – AM_R5;
    • Inference search:
      – AnalyseMe <meal plan> contains elements that indicates the consumption of <food resource>.
Conflict Diagnosis

- **Basis feature** is the food resource, the HomeHub and the AnalyseMe system and the list of the identified conflicting requirements;
- **Degree feature** represents the requirement satisfaction level
  - Food resource should be >=20, however it is 16.
- **Direction feature** is positive (the food resource usage is higher than the expected);
- **Likelihood feature** is based on historical data of past conflict resolution associated with the involved requirements.
**Conflict Resolution**

**Configurable Utility Function considering:**
- Global X Local
  - Priorities
- Requirement Satisfaction Degree
- Resource Usage
  - Individual and/or Overall

<table>
<thead>
<tr>
<th>Resolution Method List (Robinson et al., 2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxation</td>
</tr>
<tr>
<td>Refinement</td>
</tr>
<tr>
<td>Abandonment</td>
</tr>
<tr>
<td>Compromise</td>
</tr>
<tr>
<td>Postponement</td>
</tr>
<tr>
<td>Restructuring</td>
</tr>
<tr>
<td>Reenforcement</td>
</tr>
<tr>
<td>Replanning</td>
</tr>
<tr>
<td>Helping Hand</td>
</tr>
<tr>
<td>Sacrifice</td>
</tr>
</tbody>
</table>
Conflict Resolution

Considering the example:

1. **Relaxation** over the food resource limit level from 20% to 15%;
2. **Replanning** using an alternative goal of AnalyseMe and generate a Meal Plan to consume less from food resource;
3. **Helping Hand** using a smart city level component and invoking a shopping list from a supermarket to increase the food level;

<table>
<thead>
<tr>
<th>Resolution Method List (Robinson et al., 2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxation</td>
</tr>
<tr>
<td>Refinement</td>
</tr>
<tr>
<td>Abandonment</td>
</tr>
<tr>
<td>Compromise</td>
</tr>
<tr>
<td>Postponement</td>
</tr>
<tr>
<td>Restructuring</td>
</tr>
<tr>
<td>Reenforcement</td>
</tr>
<tr>
<td>Replanning</td>
</tr>
<tr>
<td>Helping Hand</td>
</tr>
<tr>
<td>Sacrifice</td>
</tr>
</tbody>
</table>
• Exploring the effect of different conflict resolution methods on the utilization of the resources managed by the SoS.
  – Two Simulated Scenarios of FmFm;
  – Use of 3 Resolution Methods:
    • Abandonment;
    • Relaxation;
    • Refinement.
Initial Evaluation

Abandonment

Refinement

Relaxation
Future Work

• Investigate and implement the diagnosis and resolution steps (e.g.: expand the utility function);
• Full implementation of the framework;
• Evaluation of the framework using realistic domains/case studies;
Thank you.

Thiago Viana, Andrea Zisman and Arosha Bandara

*Faculty of Science, Technology, Engineering and Mathematics*

*School of Computing & Communications*

*Adaptive Security and Privacy (ASAP) research programme*