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
Example of an SoS
Feed Me Feed Me (Bennaceur et al, 2016)

AnalyseMe

SmartCity

HomeHub

SmartNation

AWASE - 2017
• **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>`.
Framework Overview

SoS-1

Ontology

StC

CS-1

SoS-N

Ontology

StC

CS-N

Conflict Manager

Conflict Identification

Overlap Detection

Conflict Req. Map

Knowledge

Conflict Diagnosis

Conflict Resolution

StC

Ontology

Req-N

CS-1

StC

Ontology

Req-N

CS-N
Conflict Identification

- Assertions Monitor
- 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

ENTITYs (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 requirements 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 $\geq 20$, 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.
Conflicted Resolution

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

Resolution Method List (Robinson et al., 2003)

- Relaxation
- Refinement
- Abandonment
- Compromise
- Postponement
- Restructuring
- Reenforcement
- Replanning
- Helping Hand
- Sacrifice
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 <em>et al.</em>, 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><strong>Helping Hand</strong></td>
</tr>
<tr>
<td><strong>Sacrifice</strong></td>
</tr>
</tbody>
</table>
Initial Evaluation

• 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
Invesigate 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*