

MODELING AND REASONING ABOUT CONTEXTUAL REQUIREMENTS

Raian Ali, Fabiano Dalpiaz, Paolo Giorgini



UNIVERSITY OF TRENTO - Italy
Information Engineering
and Computer Science Department

MOTIVATION



- Some requirements aren't absolute, but context dependent:
 - Context stimulates a requirement
 - It is humid inside → fresh air is required
 - Context enables an alternative to meet a requirement
 - It is sunny and not windy outside → windows can be opened
 - Context influences the quality of each alternative
 - He is sleeping → opening windows violates his privacy/comfort
- Meeting requirements leads to changes in context.
 - Opening the windows → opened windows and high light level



MOTIVATION..



- Most RE presumes uniform, not varying, contexts.
- In emerging computing, like UbiCom, PerCom, Aml, this assumption is no longer valid.

- **Why Context with Goals?**



- Context influences human intentions & choices **first**.
- Software has to **reflect** human adaptation to context.



- **Example:**
 - if a context like *“tourist has not had lunch yet and it is around lunch hour”* holds
 - the tour guide will try to reach a goal like *“find a place for tourist to eat”*.
 - Moreover, the context *“tourist is vegetarian”* will limit the restaurants from which the guide would choose..



CONTEXTUAL GOAL MODEL

[CAISE08, ER08, CAISE09 FORUM, EMMSAD09]

CONTEXTUAL GOAL MODEL

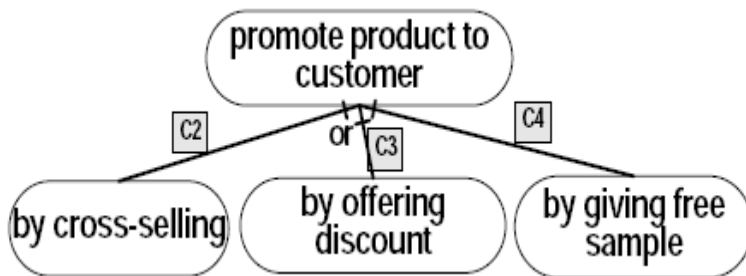


- **Context** is the reification of the environment that is whatever provides a surrounding in which the system is to operate [Finkelstien STRAW'01].
- Adaptability is, essentially, **selecting between variants**.
- Associating each goal model variant & context is hard:
 - Exponential number of variants
 - Inability to understand variant at once.
- To bypass, we identify context on **variation points** in the goal model.



VARIATION POINTS

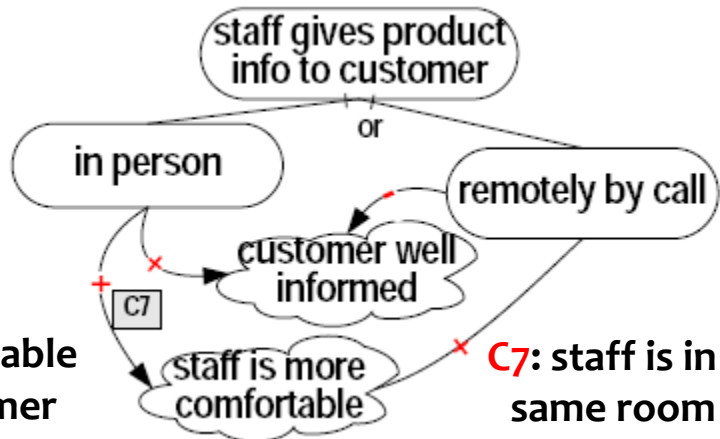
- 1. Or-Decomposition:** each variant could require a valid context to be adoptable.
- 2. Contribution:** contributions to softgoals are not absolutely positive or negative.



C2: product compliments another one the customer already has.

C3: product is discountable & interesting to customer

C4: product is free sampled & new to customer

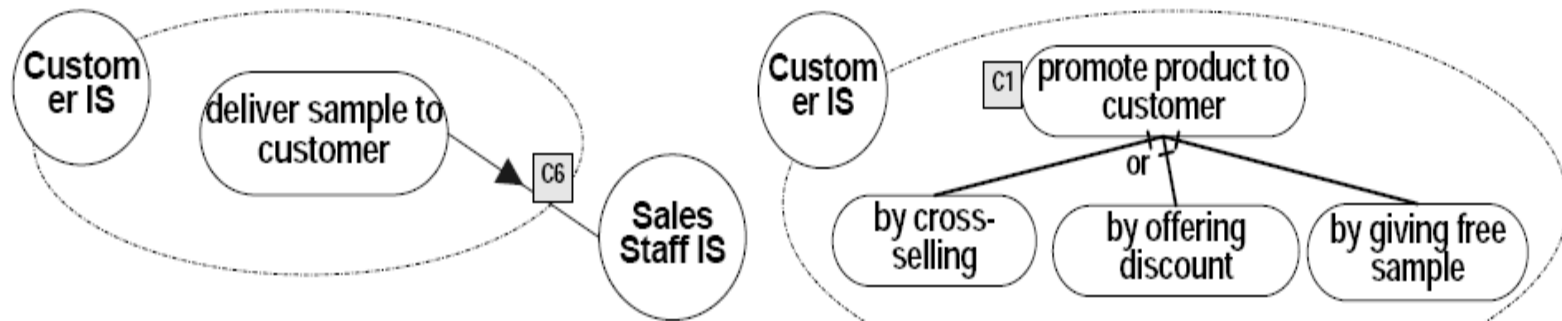


C7: staff is in the same room as customer

VARIATION POINTS



- 3. **Actors Dependency**: to depend on other, a certain context has to hold.
- 4. **Root goals**: context stimulates root goals



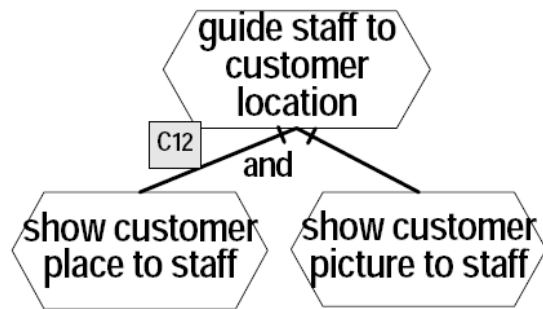
C6: staff is free, speaks a language common to customer, knows well the product, and close to customer

C1: enough time to promote, customer is not in a hurry, customer does not have the product

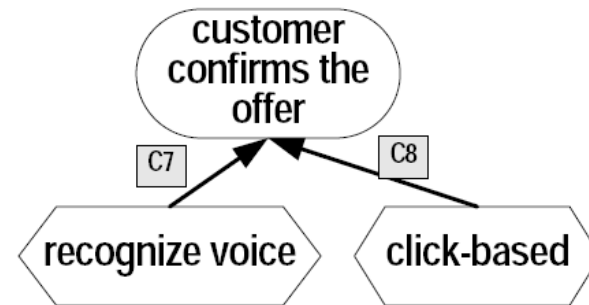
VARIATION POINTS



- 5. **And-Decomposition**: certain contexts make a subgoal /subtask in an And-decompsition needed.
- 6. **Means-end**: some tasks require a valid context to be adoptable in a means-end analysis.



C12: customer is not around and can not be seen directly by the sales staff



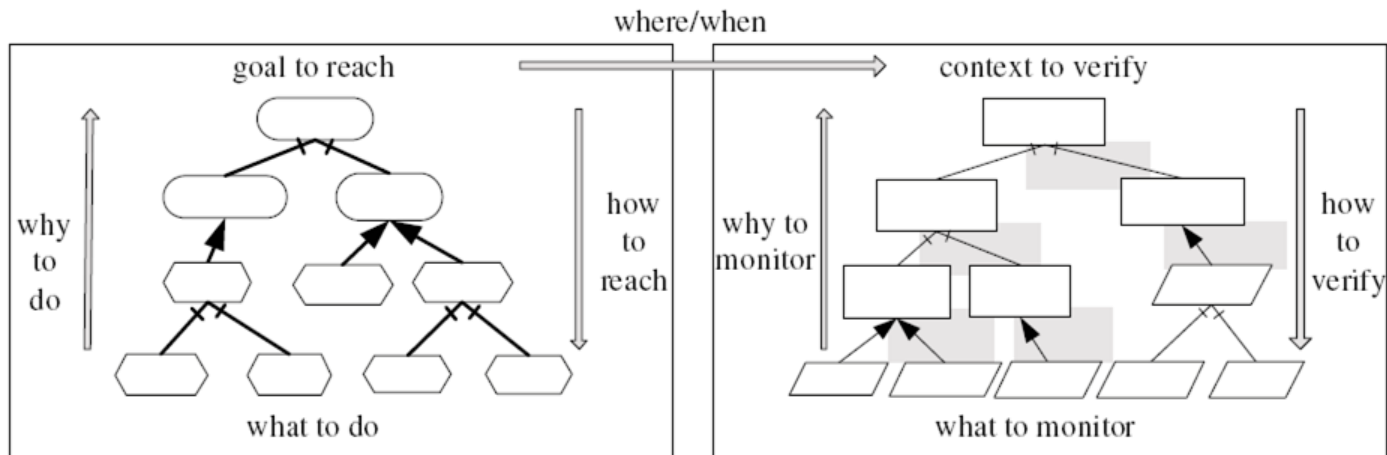
C7 : the customer place is not noisy, the system is trained enough on the customer voice

C8: customer has technology expertise and the used device has a touch screen

CONTEXT ANALYSIS



- While Goal is a state of the world to reach; Context is a state of the world that is the case.
 - We analyze goals to know what **to do to reach** them
 - We analyze contexts to know what **to monitor to verify** them.

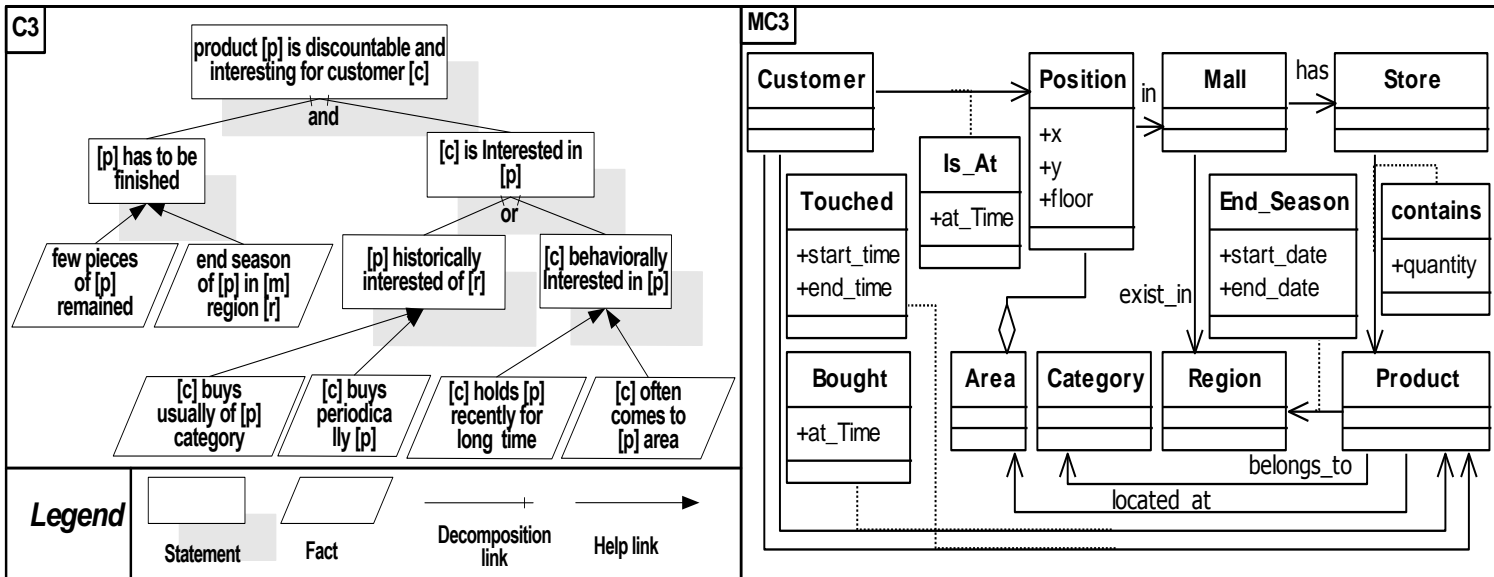


CONTEXT ANALYSIS CONSTRUCTS



- **Fact**: a predicate specifying a context, its truth value can be objectively computed.
 - E.g. F1: customer never bought the product [p] from the mall.
- **Statement**: can not be objectively computed.
 - E.g. St1: Customer does not have the product [p]
- **Help**: F : fact, S: statement. $\text{help}(F,S)$ iff $F \rightarrow S$.
 - E.g. $\text{Help}(F1,St1)$
- **Decomposition**: or/and of facts and statements.
 - E.g. customer is interested in product: (i) behaviorally or (ii) historically.

CONTEXT ANALYSIS NOTATION

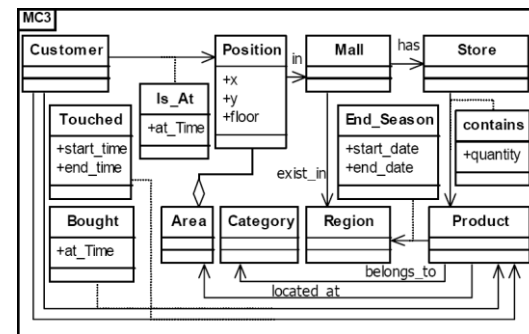
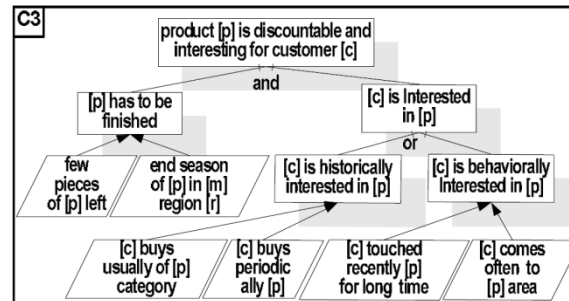
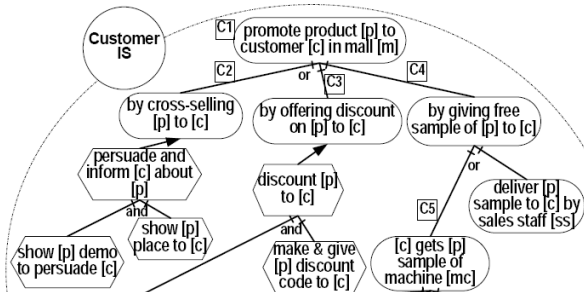


CONTEXT EFFECT TAXONOMY



- For each goal model variant:
 - **Stimulating context**: the conjunction of contexts at the Root goal and And-decompositions.
 - tourist is hungry
 - **Required context**: the conjunction of contexts at Or-decomposition, Means-End, and Delegation.
 - there is a close restaurant that accepts tourist credit card
 - **Quality contexts**: for each (variant, SG contribution).
 - the restaurant is close enough.

OVERALL





REASONING ABOUT CONTEXTUAL GOAL MODEL

FORMALIZATION



- The context analysis hierarchy translated to **Boolean formula** of leaf facts as variables.
- The contextual goal model into **Datalog**.
- A **prototype tool** “RE-Context” has been implemented.
- Up to now, we encode the model manually.

VALIDATION



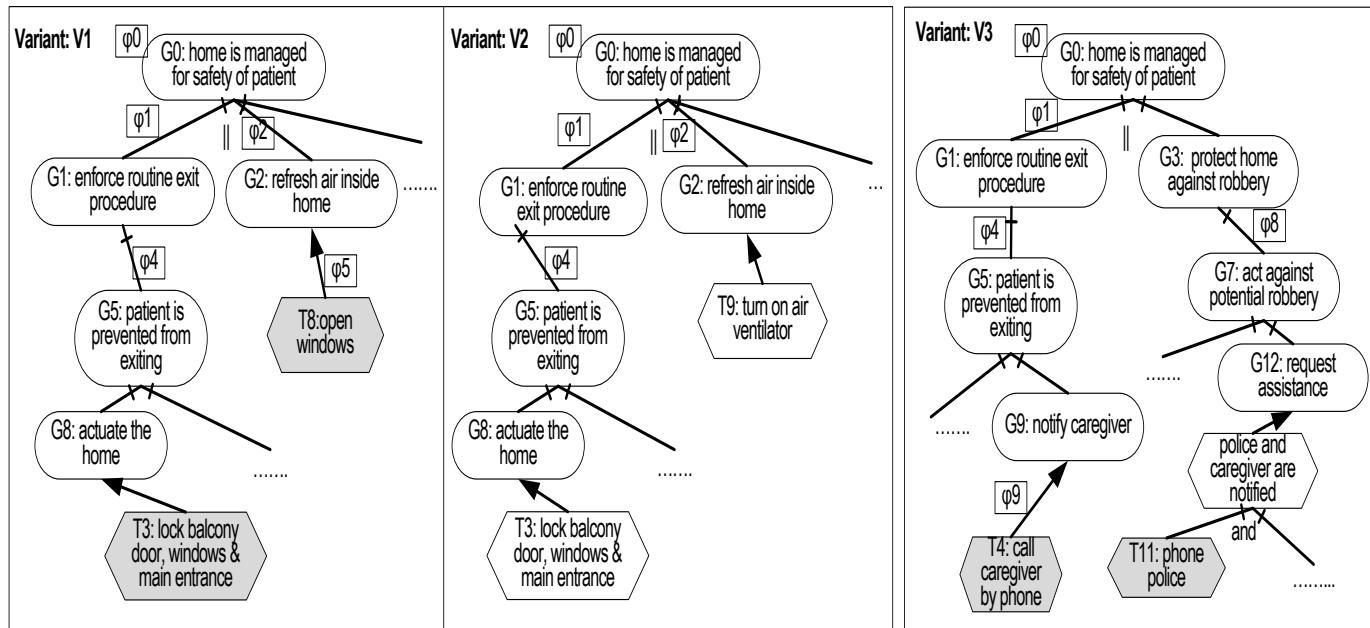
- We developed reasoning to **validate the context** of each goal model variant :
 - Relations (implication and contradictions) are specified between contexts (at whatever level of the context hierarchy).
 - **SAT solver** is used to find a model for the conjunction of the Boolean formula expressing a context and the assumed relations.
- Note: the **compact form of goal model** could naturally include variants with inconsistent contexts. i.e. not necessarily modeling errors, but indeed unadoptable.

EXPLAINING CONFLICTS



- We provide reasoning to detect conflicts **and**:
 - The goals behind them.
 - The context in which they happens.
 - The alternatives that can avoid us the conflict.
 - The conflicts that are Core where a resolution is critical.
- **As an example: Water Conflict.**

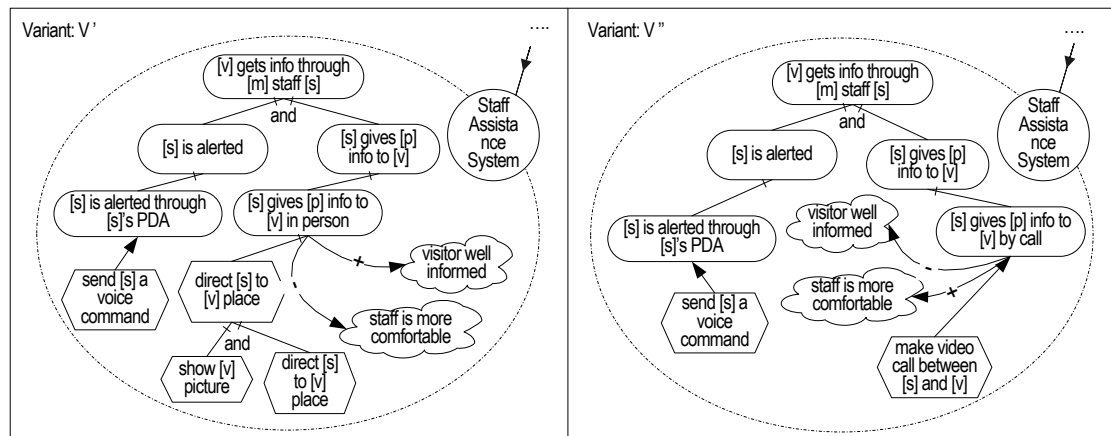
EXAMPLE



CONTEXTUALIZATION



- Given a **context** and a **user prioritization**, we derive a suitable goal model variant.
- Prioritization is given over softgoals for two reasons:
 - Bypassing the enumeration of goal model variants.
 - Talking to stakeholder in their terms.

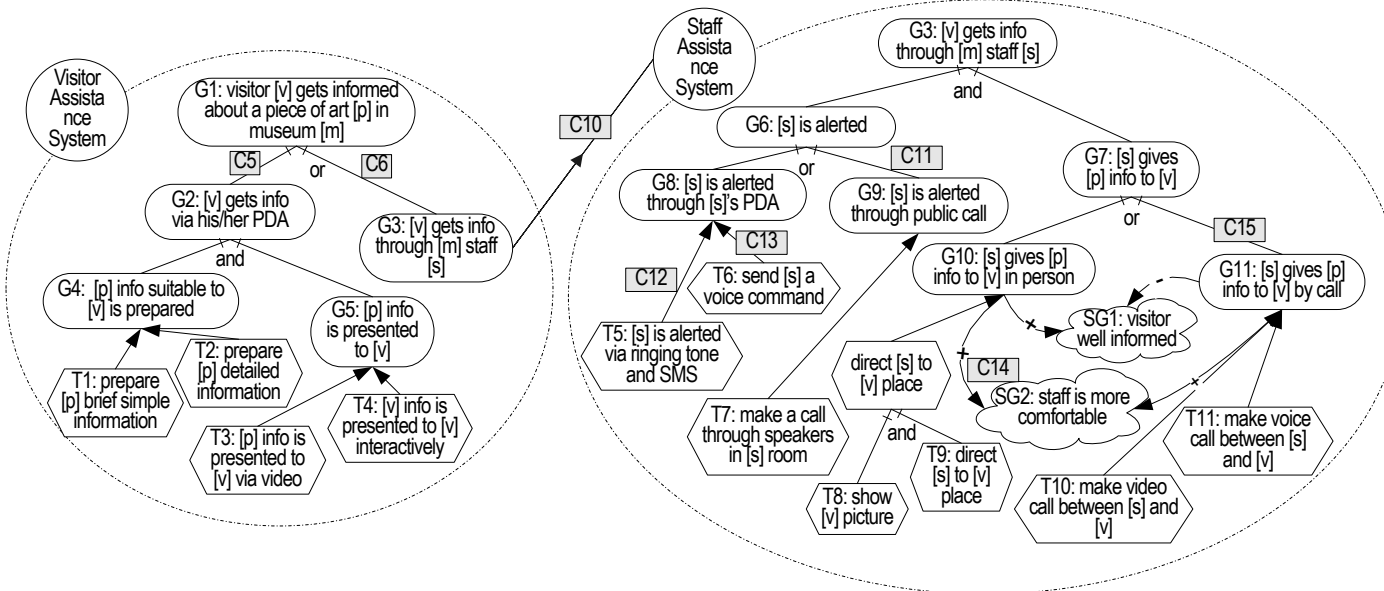


DERIVING CORE REQUIREMENTS



- **Core requirements** are system requisite that can't be bargained on.
- Discovering them is useful for timing & budget constraints, and when flexibility & quality is not a main issue. I.e. when we need just a **Valid System**.
- The variants that, at certain context, have no alternatives are core.
 - We discover core variants. (actually, core groups!)
 - We process the groups to elicit variants for minimum costs.

EXAMPLE



The non-core variant	The variants excluding the non-core variants	The core groups of variants	The cost relations	The min-cost core requirements
NV1 = {T6, T10} NV2 = {T6, T11} Both can be replaced by V2 due to the implications: C13→C12 and the trivial C15 → true.	V1 = {T1, T3} V2 = {T1, T4} V3 = {T2, T3} V4 = {T2, T4} V5 = {T5, T8, T9} V6 = {T7, T8, T9}	Core1 = {V1, V2, V3, V4} Core2 = {V5} Core3 = {V6}	Cost (T1,30), Cost (T2,40), Cost (T3,60), Cost (T4,80), Cost (T5,25), Cost (T6,35), Cost (T7,50), Cost (T8,30), Cost (T9,50), Cost (T10,50), Cost (T11, 30). Include (T2, T1), Intersect (T3, T4, 40), Intersect (T3, T5, 20), Intersect (T4, T5, 20), Intersect (T4, T9, 30) Cost = 340 (development of all variants)	The variants to develop = {V2, V5, V6} The tasks to develop = {T1, T4, T5, T7, T8, T9} Costs = 215 (development of the core variants V2, V5, V6)



COLLABORATIVE WORK

IIWSPM@RE09 , DSPL@SPLC 09I



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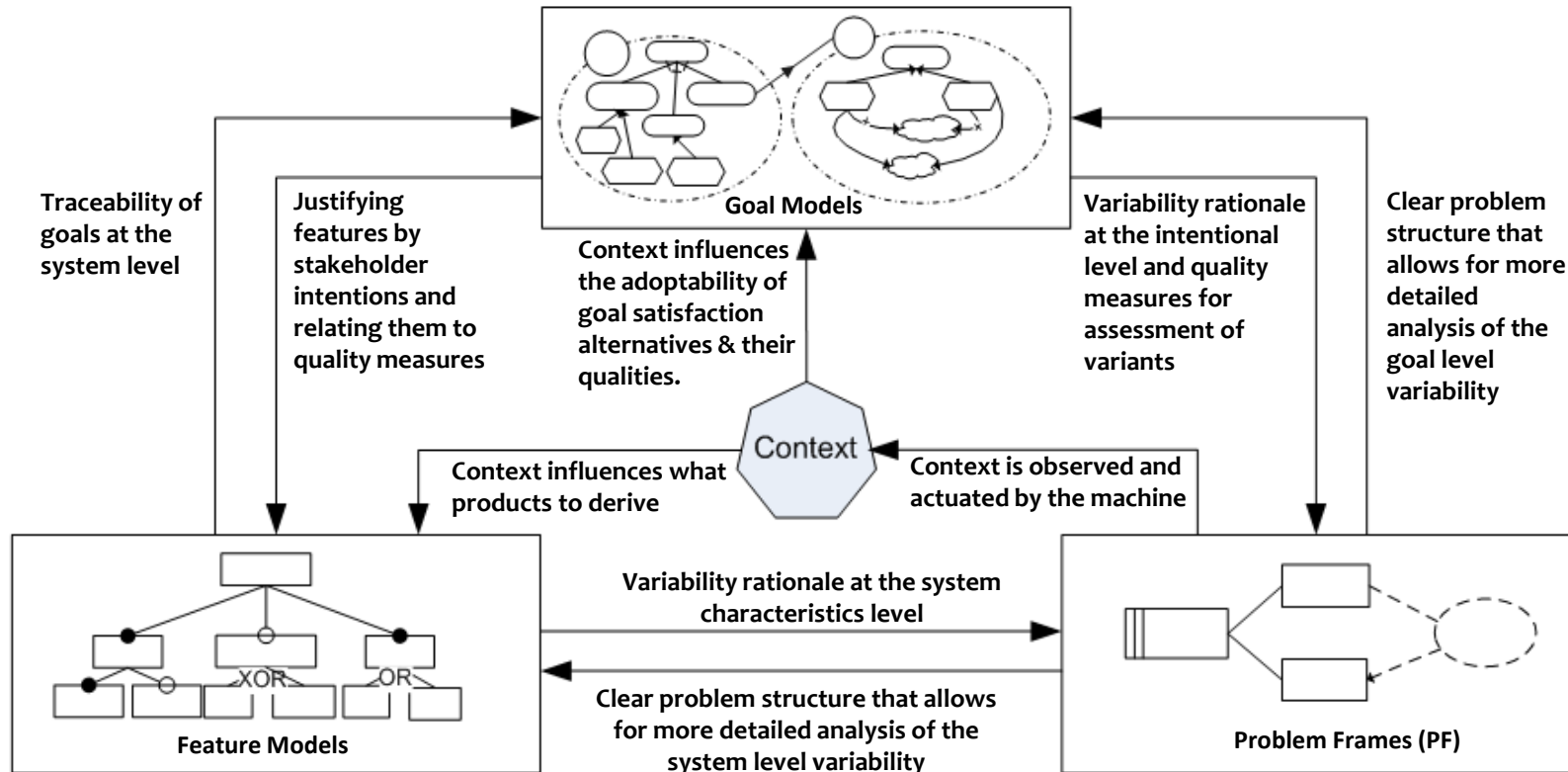


The Open University

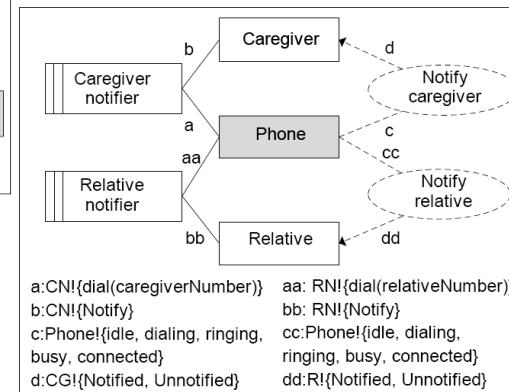
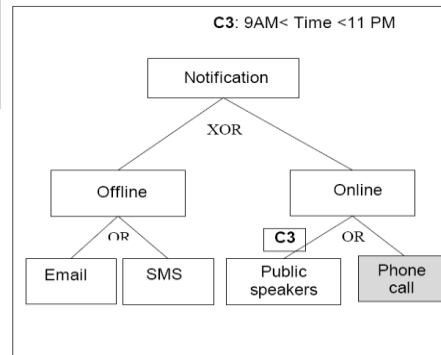
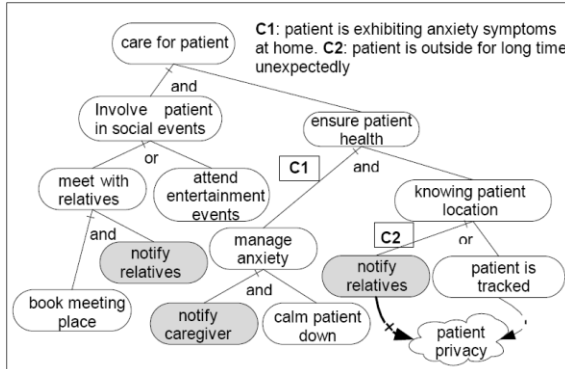
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AN INTEGRATED FRAMEWORK



USEFULNESS OF INTEGRATION



CONTEXT FOR GOAL LEVEL SPL



- Variability is that of human intentions and choices first.
- Context influences decisions at this level first.
- A Dynamic SPL has to reflect such adaptation to derive a contextualized product variant.
- We introduced the terms:
 - Online SPL Contextualization.
 - Offline SPL Contextualization.
 - Maintenance based on operation in multiple contexts.

FUTURE 3 WORKS



- **Lifelong Contextualization!!**
 - “What are the requirements? Well, it depends on the context, but I do not know exactly how”.
- **Viewpoints in Context Specification:**
 - E.g., Tourist is interested in attending a cultural event if
 - the event conveys very new information
 - If the event is related to the tourist culture.
- **Security Requirements in Varying Vontexts.**
 - E.g., unless I am unconscious or far away from my city, no one but my private doctor can see my medical record without my permission.