

# Co-Configuration of Products and On-Line Service Manuals

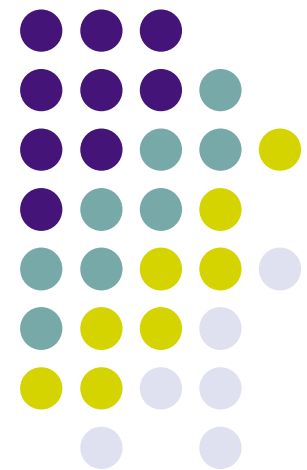
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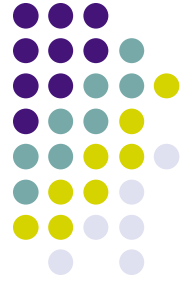
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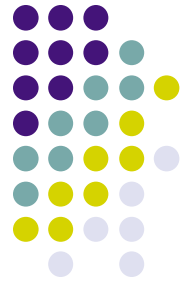




# Outline

- **Complex Products:** SIEMENS Magnetic Resonance Tomographs
- **Complex Service Manuals:**
  - Have to cover all product instances
  - Complicated maintenance procedures
- **Goal:** Each manual individually configured for each product instance

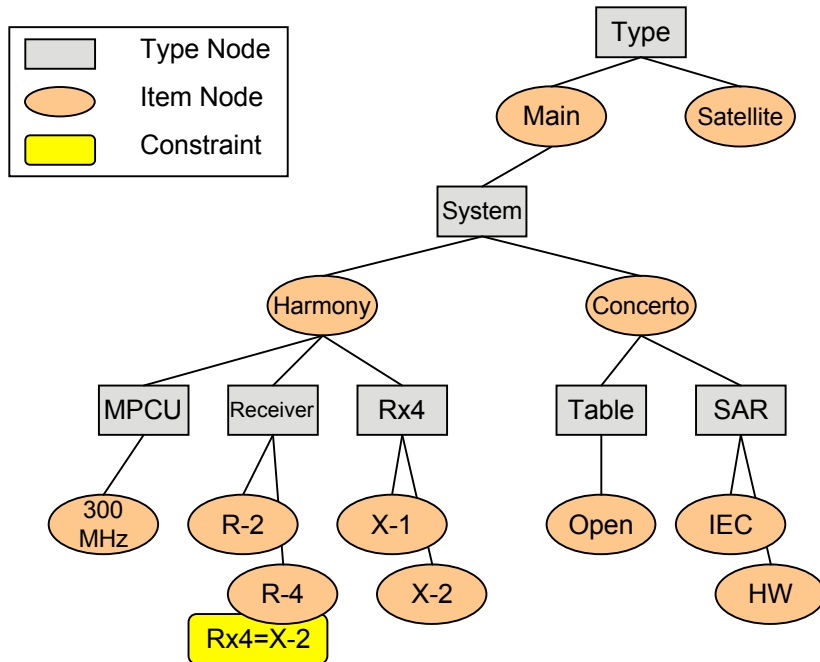
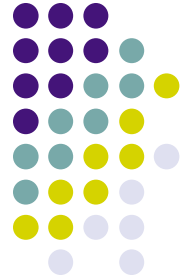
# The Product: Magnetic Resonance (MR) Tomographs



- 11 basic MR systems (model lines):
  - Concerto, Symphony, Harmony, ...
- Total of 47 configurable component types, e.g.:
  - 14 different gradient power amplifiers
  - 82 different coils (for examination of different parts of the body)
  - 9 different gradient coils
  - 20 service-software add-ons
  - 2 railway mains frequency EFIs
  - 45 destination countries (e.g. India, Czech Republic,...)
  - ...



# MR Product Structure



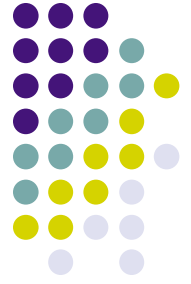
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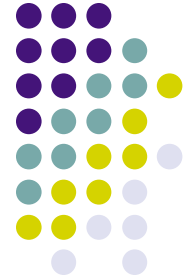
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- Product structure translatable into propositional logic formula  $F$
- Configuration option  $\cong$  propositional variable
- Valid configuration  $\cong$  model of formula  $F$

# The Manuals: Split into HelpPackages



- Each manual configured individually for each product instance
- Manuals composed of smaller handbook fractions (*HelpPackages*)
- Additional specification (*HelpContexts*) indicates what makes a complete product manual



# Product Manuals: Example

**Manual 1**

**For Product Instance:**  
System=Harmony, MPCU=300MHz,  
Receiver=R-4, Rx4=X-2,...

HelpPackage 1: Introduction

HelpPackage 3: QA Harmony

HelpPackage 4: Tune-Up Harm.

HelpPackage 5: Magnet Cooling

HelpPackage 8: Backup&Rest.

**Manual 2**

**For Product Instance:**  
System=Concerto, Table=Open,  
SAR=IEC,...

HelpPackage 1: Introduction

HelpPackage 2: QA Concerto

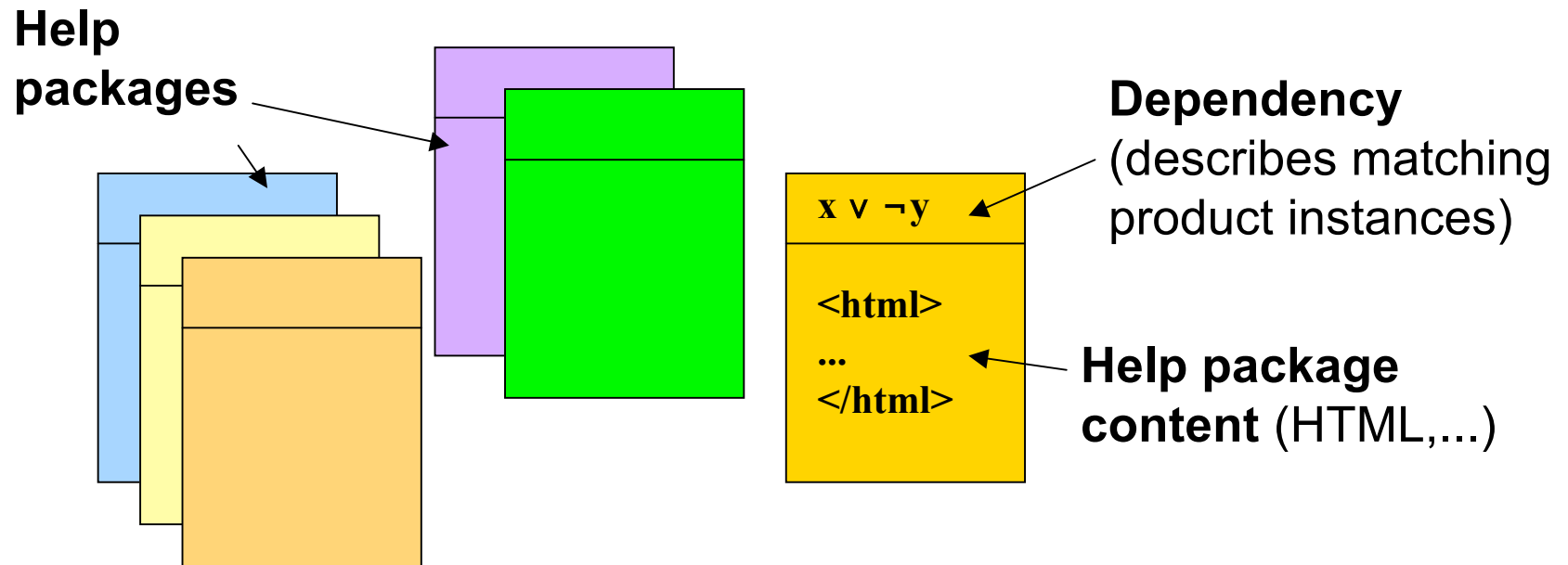
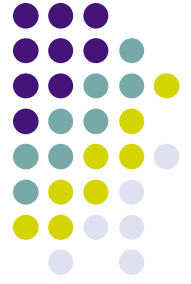
HelpPackage 7: Tune-Up Conc.

HelpPackage 5: Magnet Cooling

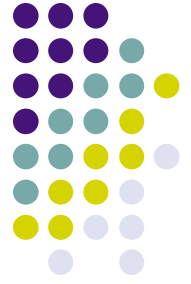
HelpPackage 8: Backup&Rest.

HelpPackage 10: Dicom Tests

# Modular Help System: Selection of Packages



Automatic selection of appropriate packages  
based on *dependencies*.

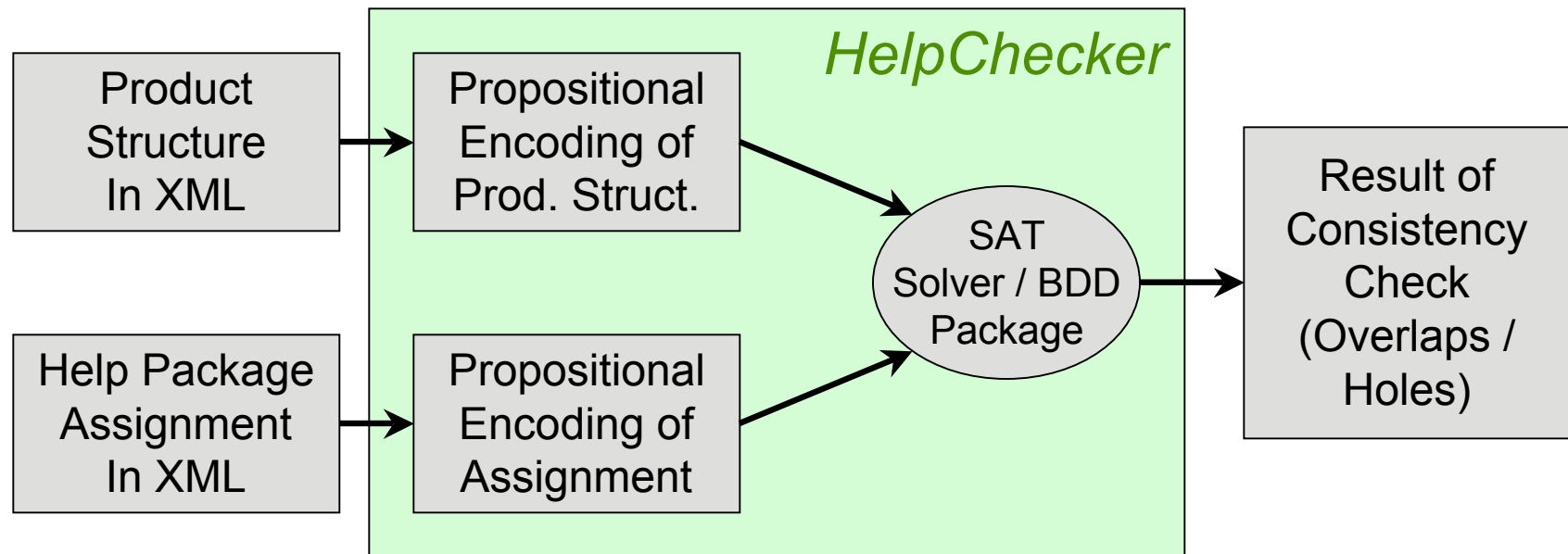
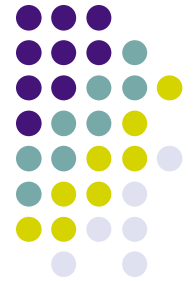


# Consistency Issues

- **Are the manuals complete?**  
Or are there missing pages/sections?
- **Are there ambiguities in the manuals?**  
I.e. more than one help package for a certain topic
- **How are these issues resolved?**
  - Translation into propositional logic satisfiability / validity problem
  - Generated problems solved by SAT-solver / Binary Decision Diagrams (BDDs)  
⇒ *HelpChecker*

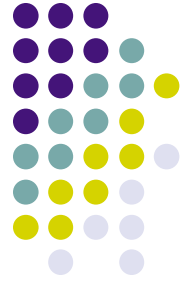


# Consistency Checks with the *HelpChecker*



[For details on propositional encoding see our ICFEM 2004 paper.]

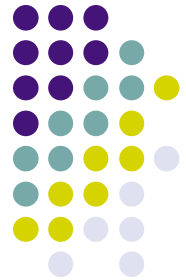
# Implementation & Experimental Results



- *HelpChecker* is part of a larger authoring tool
- MR product structure and help packages stored in XML data base, *HelpChecker* implemented in C++
- Propositional encoding of product structure results in:
  - 1425 propositional variables, 11018 clauses (CNF SAT encoding), 9715 formula nodes (BDD)
- Run-time for complete check:
  - ~50s (on 3 GHz Pentium 4 with 1 GB Memory)
  - 4 model lines, 3871 help contexts, 928 help packages

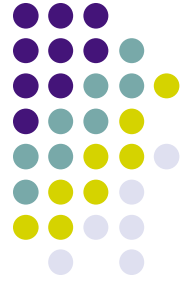
# SIEMENS

## Authoring System GUI



The screenshot displays the 'Online-Help VF10A' window with the following components:

- Current Dependencies:** Shows a tree view for 'Dependency 1' with sub-items: System Type, Allegra, and Number of RX Boards (1). An 'Edit' button is located below.
- Filter Settings:** Shows a tree view for 'Dependency 1' with sub-items: System Type and Allegra. Below are 'Edit' and 'Activate' buttons.
- Help Structure:** A tree view of help topics. The selected item is 'HP-Z00011BB-040304-02-070' under the 'RF Characteristic' folder. Other folders include 'Adjust Table Distance', 'Phantom Shim', 'Cross Term Compensation', 'Eddy Current Compensation', 'Gradient Delay', 'Gradient Sensitivity', 'Receive Path Calibration', and 'Quality Assurance'.
- Help Packages:** A vertical stack of buttons: 'Insert', 'Edit', 'Copy', 'Paste', 'Delete', and 'Properties'.
- Translation:** A vertical stack of buttons: 'TTM Checkout' and 'Check Translation'.
- Bottom Panel:** Contains 'Edit' and 'Activate' buttons, and a red-bordered box containing 'Check Consistency' and 'All' buttons.



# Summary

- Modular handbooks for complex products are feasible
  - Can be generated automatically out of a set of handbook fractions (HelpPackages)
  - HelpPackages are annotated with propositional logic formulae to indicate associated product instances
- Exact semantics (translation of XML terms into propositional logic) enables automatic consistency checks
  - Automated reasoning techniques (SAT-Solvers, BDDs) sufficiently advanced