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Topic 52	within each of these three groups of facets, of
Requirements Facets	◊ (i) projections, determinations, instantiations, extensions and fittings, respectively of
• The prerequisite for following this (part of the) lecture is that	\diamond (ii) shared data initialisation and refreshment, computational
you, as a requirements engineer, need to know: what are the	data and control, man-machine dialogues, man-machine
constituents of a proper model of requirements?	physiological, and machine-machine dialogues, and of
• The aims are	\diamond (iii) performance, dependability, maintenance, platform, and
\star to introduce the concept that a proper requirements prescription	documentation requirements respectively;
is made up from most of the following constituent prescriptions,	and
i.e., facets:	\star to present principles, techniques and tools for the prescription of
\diamond (i) domain,	these facets.
\diamond (ii) interface and	
\diamond (iii) machine requirements, and,	
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• The objective is	Throughout requirements engineering remember to adhere to:
\star to ensure that you will become a thoroughly professional	The "Golden Rule" of Requirements Engineering $\operatorname{Prescribe}$ only those
requirements engineer.The treatment is from systematic to formal.	requirements that can be objectively shown to hold for the designed software.
	• "Objectively shown" means that the designed software can
	\star either be proved (verified),
	\star or be model checked,
	\star or be tested,
	• to satisfy the requirements.
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	• After such a requirements acquisition stage
Rough Sketching and Terminology	• we can analyse the acquired requirements prescription units.
• The aim of this part of the lecture	• And after such an analysis we are ready to
• is to remind the student	\star rough sketch, i.e., to make a first attempt at constructing, some
• that in order to come up with a proper model of requirements	requirements document,
	\star while, at the same time, establishing a terminology document.
• we must first have	• In this lecture we shall overview these two aspects of
 ★ performed proper identification of and ★ requirements acquisition from stakeholders. 	"Requirements Engineering".
* requirements acquisition nom stakenoiders.	
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Initial Requirements Modelling	Rough-Sketch Requirements
• In Example 17.166	• A rough-sketch requirements prescription
• we illustrated examples of	• is (thus) based on a number of partially "digested", i.e., partially
* "one", or "two", or "three liner"	analysed and conceptualised, requirements description units.
* requirements description units.	• The requirements engineer is encouraged to try to formulate
• Once,	• a reasonably complete and consistent rough-sketch requirements
* as a result of requirements acquisition	prescription,
• you have gathered what you may think of as a sufficient number of such analysed requirements description units,	• in order to do a more thorough requirements analysis and concept formation.
• you are ready to rough sketch a requirements prescription.	
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• The requirements description units, in a sense, only express the stakeholders' views on requirements.	Example 19.170 A Rough-Sketch Container Terminal Domain: To illustrate a rough-sketch requirements we need first be able to refer to a domain description. In this case we present a rough-sketch
• These units may reflect a somewhat incoherent "total view".	domain description.
• After a reasonably proper requirements analysis and concept	Entities
formation stage,	We itemize list entities of container harbours, in no particular order,
• the requirements engineer (i.e., the analyst),	only as they come to mind:
• is able to formulate a more coherent total view.	
• Rough-sketching these requirements thus affords a first opportunity for the requirements engineer to express the requirements.	
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• Container terminal: A container terminal is a composite entity. It consists of a harbour basin of water, of one or more quays, of one or more container pools, and of zero, one or more container freight	• Quay: A quay is a composite entity. A quay is like a straight road: The quays connect on one side to the harbour basin, and on the other side, possibly via a container terminal internal road net, to
stations. The harbour water basin connects on one side to the open sea, and on the other side to one or more quays. Attributes of a container terminal are: its name, its maritime location (latitude and longitude), its number of quays, number of pools, etc.	one or more container pools, and, possibly via these, to the possible container freight stations. The quay also consists of one or more cranes. Quays have attributes: length, width, number of cranes, position within the container terminal, possibly a name, etc.

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• Container ship: A container ship is a composite entity. It consists of one or more locations which can each hold, or which actually hold a container. So the container ship also consists of these containers. Container locations are called cells, and cells are laid out in bays, rows and tiers (like an x, y, z coordinate system). Thus containers are stacked. The container she accessible from the top, through what is called a hatchway, an opening, that can be covered by what is called a hatch cover. This hatch cover is removed when unloading and loading containers to the appropriate stacks that it covers. Ship attributes have to do with the exact arrangement of bays, rows and tiers, actually carry. Ships can berth at a quay. They then occupy a certain length of that quay.
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 Functions Calling: A container ship contacts, i.e., calls, a container terminal to advise it of its intended arrival, giving its call sign. The 'calling may, or may not imply a request for permission to go to a previously scheduled quay position. Unloading movement: This is a simple function and could be regarded as an atomic function. Often it is called a movement. The function concerns the unloading of a single container from a cell position aboard the container ship by a designated crane onto a container truck or a container chassis. Loading movement: See the above, since it is basically the

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These two movements reflect the fact that container truck and	Events
container chassis can only move one container at a time.	We rough-sketch some possible events:
• Chassis/truck movement: We also consider this a simple,	• The arrival of a container vessel to a quay position
atomic function: Moving, by motor driven vehicle, one container	• The departure of a container vessel from a quay position
from a crane at a quay to a crane at a pool, or vice versa.	
• Hatch cover removal (opening): An atomic function which	• The failure to remove (to open) a hatch cover
opens up for the hatchway so that containers can be loaded or	• The failure to replace (to close) a hatch cover
unloaded.	• The failure of a crane to grip a container
• Hatch cover replacement (closure): An atomic function	• The failure of a crane to release a container
which closes the hatchway.	• The failure of a container truck/chassis to move
	• The failure of a container vessel to move
	• The outbreak of an epidemic disease
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Behaviours	• A merchant freight truck visit: A freight truck usually carries just one
	(say a 40-foot) container, or, in cases, two (20-foot) containers. A merchant
• A ship visit: A normal, "uneventful" ship visit behaviour starts with the ship calling (action) and proceeds to the arrival of the	freight truck is a freight truck which carries one merchant's container(s), overland, to or from a container terminal. Its visit is for three purposes: to
container vessel at a quay position (event). Some hatch covers may	deliver one or two containers, to fetch one or two containers, or both. Its
be opened. It then continues with one or more concurrent	behaviour wrt. the container terminal is: arrival (an event) at the container terminal registration (a function) at the container terminal rate (statement of
sequences of container unloadings and loadings (actions). It ends	terminal, registration (a function) at the container terminal gate (statement of purpose, showing of papers (waybills, bill of loadings), etc.), unloading and/or
(possibly) with the closing of hatch covers (actions) and the	loading of containers (either at a special area, called the container yard (or, in
departure of the container vessel from the quay position.	certain cases, at the container freight station), or directly to a pool area, or, even, directly on the quay, for immediate ship loading or unloading).
	• A 24-hour crane behaviour: We encourage the course student to try
	• A 24-hour crafte behaviour: we encourage the course student to try complete this item as an exercise.
	• A 24-hour container truck/chassis behaviour: We encourage the course
	student to try complete this item as an exercise.
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\bullet Now, on the background of the above rough domain sketch,	2. Bill of Lading: The BoL states the route which the container, c , is to take, or is taking an host three. It is a previous set that the parton shell states him and
• we are ready to express a rough requirements sketch.	is taking or has taken. It is a requirement that the system <i>shall</i> establish and maintain BoLs for all relevant containers.
Example 19.171 A Rough-Sketch Requirements for Container	3. [Ship sailing] route: A route is here considered a sequence of two or more
Stowage: After some discussion with stakeholders we arrive at the	container terminal visits. A container terminal visit is a pair: the name of a
following base requirements for a ship and pool areas container	container terminal (T) and the name of a container ship (s) or, for the last in such a sequence, say nil . The ship S takes the container C from container
loading plan computing system. (What we here name ship and pool	terminal t. Let $r : \langle (t_1, s_1), \ldots, (t_i, s_i), (t_{i+1}, s_{i+1}), \ldots, (t_n, nil) \rangle$ designate a
area container loading plans are, more colloquially, called stowage plans.)	route for some container. It expresses that that container is transported from container terminal t_i to container terminal t_{i+1} by container ship s_i . It is a
	requirement that the system <i>shall</i> establish and maintain ship sailing routes, for
1. Container: Every <i>container</i> c (that is to be involved in the planning of loading plans, and hence subject to actual loading and	all of a ship owner's relevant container ships.
unloading) shall possess the following attributes: (i) length and	
(ii) BoL, <i>b</i> .	
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4. Ship container stack layout ('context'): For every relevant / container ship (say, in the ship owner's fleet of such), full	6. Pool area container stack layouts ('context'): For every relevant container terminal, and for every container pool area (that
information shall be maintained of how each ship is laid out	is relevant to the ship owner for which these requirements are to be
wrt. container stacks (this is called contextual information).	developed, and within these container terminals), information
5. Ship container stack 'state': For every container ship being	about the topological layout and pool area stacks, whether for
considered, we further require that a state shall be maintained.	ordinary containers, or for reefers, whether for 20-foot or for 40-foot
The state is information about the location of all current	(etc.) containers, shall be kept and regularly updated to reflect
containers: where, aboard, i.e., in which stack and cell position,	any changes in pool area layouts, etc.
they are stored. A well-formedness about this state expresses that	
each container has a BoL which states that it should indeed be	
cach container has a DOL which states that it should indeed be	
aboard that ship at the moment the state is recorded.	

2 Rough-Sketch Requirements Technical University of Dennak	Ħ	0.2.2 Rough-Skatch Requirements Tachiad Using data	DTU ₩
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current containers being stored in that pool area stack and their location, that is, BoLs and where (i.e., bay, row, cell position), etc.		 (a) Pragmatics: Outstanding (container shipping) order. By an outstanding (container shipping) order we mean an order for a container transport, i.e., an order whose transport is being requested, but for which no acknowledgement of its precise shipping has yet been given. (b) Syntax: Outstanding (container shipping) order. The order document specifies (i.e., restates) the BoL of the container and a sequence of one or more container terminals. (c) Semantics: Outstanding (container shipping) order. The meaning 	
		of an outstanding (container shipping) order is, if it is accepted, that it enters the allocation and scheduling process of the relevant shipowner(s), and thus, eventually, is confirmed.	
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9. Confirmed (container) shipping order: By a confirmed (container) shipping order we mean a shipping order which is no longer outstanding: Its syntax has been understood, and its semantics has been implemented. That is, it has been used in the construction of one or more ship container loading plans (and possibly also in one or more container pool area loading plans). Whether the container in question is actually en route is here left	/	 10. Ship container loading plans: Based on the above forms of information, i.e., items 1–9, the required computing system shall generate two kinds of reasonably optimal ship container loading plans (i.e., documents): static and dynamic. 11. Static ship container loading plan: A static ship container loading plan is a plan that prescribes which containers are loading and unloading at which container terminals, for a given ship, i.e., for a given route that this ship is to follow, and for a given set of outstanding shipping orders. The plan also states 	/
open.		 where each container is to be located aboard the ship. 12. Dynamic ship container loading plan: Given a static ship container loading plan, and given a container terminal (i.e., the name of a terminal at which the ship for that loading plan is berthed), the dynamic ship container loading plan specifies the sequences in which containers are to be unloaded and loaded. 	
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 April 1, 2006, 1017 (2017) April 1, 2006, 10.06 Page 1500, Topic 151, Tol. 20 As an example of the issues involved in loading and unloading, let us consider the following: * Let container c_i be loaded on stack s in terminal t_i. * Let container c_{i+1} be loaded on stack s in terminal t_i or t_{i+1} (i.e., immediately "on top of" c_i). 	_/	Image (b), (util) (3A107 hands) April 5. 2006, 1305 Page 1506. Tigle: 50. Table 300 Match Themate Table 300, 100 (util) (100, 100, 100, 100, 100, 100, 100, 100	-/
 * Now container c_{i+1} can be unloaded from stack s in terminal t_{i+2}. * Container c_i can be unloaded from stack s in terminal t_{i+2}, or some suitable later terminal. That is, a stack push and pop discipline must be adhered to. 	r	14. [Reasonably] optimal dynamic ship container loading plan: A dynamic loading plan is said to be [reasonably] optimal if no other such plan can be found which generates the longest sequences of ship crane container movements with respect to the same ship stack.	
452 274, fm = 45 488 287 © Dava Bjerner, Frankry 11, 100-2016 Main, Charant Erando, Alexandrado, Agarendynard and, davendynar bis UK - wars i		15. The generation of plans: The intent of any dynamic ship container loading plan is that actual unloadings and loadings <i>shall</i> be commensurate with, i.e., "follow", that plan.	
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16. Container pool area loading plan: And so on; this plan will not be prescribed.	ı /	Lest you have lost sight of what the rough-sketch requirements really were, we here summarise these:	/
17. Container ship loadings and unloadings: By container ship loadings and unloadings we understand the sequences of ship crane		 Initialisation and refreshment of container BoLs Initialisation and refreshment of ship sailing routes 	
positions, along the quay, next to, i.e., servicing, a given ship, as well as the movement, for each ship crane position, of containers to		4. Initialisation and refreshment of ship container stack layouts	
and from the ship (i.e., from and to the quay). Since translocating a ship crane (from one quay/ship position to another) takes time		 Initialisation and refreshment of ship container stack states Initialisation and refreshment of pool area container stack layouts 	
we wish to minimise the number of ship crane translocations.		7. Initialisation and refreshment of pool area container stack states8. Storage and reference to shipping orders, includes securing item 9	
420 220, for + 46 468 261 C all State (1, 100 268 1440, David E auto Atlance duch, Sprontformation, densityper bis UK ware	mendas da/"da	b ef 621 123, Far vel 631 123 Yar vel 643 123 Yar vel 643 123 Yar vel 643 123 Yar vel 643 124 Yar vel 643 1	đu đi/~1

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11. Generation of static ship container loading plan, securing item 13	• So the above gave you some kind of rough-sketch example of what requirements
12. Generation of dynamic ship container loading plan, securing item	may entail.
14	• The example was not that small.
16. Generation of container pool area loading plan (prescription	• It had to be "semi-large".
omitted)	• You have to see, with your "own eyes", that rough sketches are not small.
17. Minimise ship crane translations, securing item 15	• In fact, they are much larger than the above example.
We remind the course student that the above constitutes a set of	 Before we proceed to the main material of these current lectures on requirements facets.
rough-sketched requirements and that we likewise presented only	• let us take a brief look at the interaction between
rough-sketched descriptions of some aspects of the domain of	
container terminals in Example 19.170.	\star rough-sketching and \star terminologisation.
	× commonSection.
455 372, fac +6 493 501 © Diest Rjører, Fredorij 11, DK-380 Mitte, Dennak E-maik & Bellensthuk, kjorer@puil.com, dent@puil.com, den	+66 603 1020, Sur: +66 688 60N
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Requirements Terminology	Example 19.172 An Incomplete Container Terminal
	Terminology:
\bullet We briefly covered, in a very early lecture, the topic of terminology.	1. Actual voyage number: A code for identification purposes of the voyage and vessel which actually transports the container/cargo.
• We do this to put that topic in a more proper context,	 Agency fee: Fee payable by a ship owner or ship operator to a port agent. Agent:
• that is, to hint at the size and complexity,	 (a) A person or organization authorised to act for or on behalf of another person or organization.
• of a realistic terminology.	(b) In P&O Nedlloyd, an Agent is a corporate body with which there is an agreement to perform particular functions on behalf of them for an agreed payment. An Agent is either a part of the P&O Nedlloyd organization or an independent body. The
• of a realistic terminology.	following functions and responsibilities may apply to the activities of an agent. i. Sales Marketing, acquisition of cargo, issuing quarkinos, concluding contracts in coordination with P&O Nedlloyd. Basically the agent is the first point of entry into the P&O Nedlloyd cognization for a shipper.
	ins point of tany into in a two recursive segmination and support. ii. Bookings Catooling of cargo in accordance with allownest assigned to the agent for a certain voyage by P&O Nedloyd. iii. Customs: Dealing with the national customs administration for cargo declarations, manifest alterations and cargo clearance on behalf of P&O
	Nedlkoyd. iv. Documentation: Responsible for timeliness and correctness of all documentation required, regarding the carriage of cargo.
	 I. Intellig: Taking care of all proceedings connected with physical handling of cargo. vi. Equipment control: Managing of all equipment stock in a particular area. vii. Issuing: Authorized to sign and sizes Bills of Lading and other transport documents.
	 viii. somming: runtionese to sign and some mus of Laiming and other transport documents. viii. Collecting: Authorised to collect freight and charges on behalf of P&O Nedlloyd. ix. Delivey: The agent who release the cargo and is responsible for its delivery to the consignee.
	 x. Handling of cargo claims: Handling of cargo claims as per agency contract. xi. Husbanding: Handling non-cargo-related operations of a vessel as instructed by the master, owner or charterer.
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4. Area code: A code for the area where a container is situated.	14. BoL: See Bill of Lading.
 Area off hire lease: Geographical area where a leased container becomes off hire. Area off hire sublease: Geographical area where a subleased container becomes off hire. 	15. Barcoding: A method of encoding data for fast and accurate electronic readability. Barcodes are a series of alternating bars and spaces printed or stamped on products, labels, or other media, representing encoded information which can be read by electronic
 Area on line subside: Geographical area where a subseased container becomes on line. Area on hire lease: Geographical area where a leased container becomes on hire. 	readers, used to facilitate timely and accurate input of data to a computer system. Barcodes represent letters and/or numbers and special characters like $+, /, -,$ etc.
8. Area on hire sublease: Geographical area where a subleased container becomes on hire.	 Barge: Flat-bottomed inland cargo vessel for canals and rivers with or without own propulsion for the purpose of transporting goods.
 Arrival date: The date on which goods or a means of transport is due to arrive at the delivery site of the transport. Arrival notice: A notice sent by a carrier to a nominated notify party advising of the arrival of a certain shipment or consignment. 	 Bay: A vertical division of a vessel from stem to stern, used as a part of the indication of a stowage place for containers. The numbers run from stem to stern; odd numbers indicate a 20-foot position, even numbers indicate a 40-foot position.
 Arrival noice: A noice sent by a carrier to a nominated noisy party auvising of the arrival of a certain singular or consignment. Auto container: Container equipped for the transportation of vehicles. 	 Bay plan: A stowage plan which shows the locations of all the containers on the vessel.
12. Automated guided vehicle system: Unmanned vehicles equipped with automatic guidance equipment which follow a prescribed path, stopping at each necessary station for automatic or manual loading or unloading.	19. Berth: A location in a port where a vessel can be moored, often indicated by a code or name.
13. Automatic identification: A means of identifying an item, e.g., a product, parcel or transport unit, by a machine (device) entering	 Bill of Lading: Abbreviation: BoL. A document which evidences a contract of carriage by sea. The document has the following functions:
the data automatically into a computer. The most widely used technology at present is barcode; others include radio frequency, magnetic strips and optical character recognition.	(a) A receipt for goods, signed by a duly authorised person on behalf of the carriers.
	(b) A document of title to the goods described therein. (c) Evidence of the terms and conditions of carriage agreed upon between the two parties.
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At the moment 3 different models are used:	26. Bulk container: A container designed for the carriage of free-flowing dry cargo, loaded through hatchways in the roof of the container and discharged through hatchways at one end of the container.
(d) A document for either Combined Transport or Port-to-Port shipments depending on whether the relevant spaces for place of receipt and/or place of delivery are indicated on the face of the document.	27. Business process: A business process is the action taken to respond to particular events, convert inputs into outputs, and produce
(e) A classic marine Bill of Lading in which the carrier is also responsible for the part of the transport actually performed by himself.	particular results. Business processes are what the enterprise must do to conduct its business successfully. 28. Business process model: The business process model provides a breakdown (process decomposition) of all levels of business
(f) Sea Waybill: A non-negotiable document, which can only be made out to a named consignee. No surrender of the document by the consignee is required.	26. Distincts protects moder. The oblights process moder provides a retainform (protects) an areves of oblights. In summary it includes all diagrams related to a process definition, allowing for understanding what the business process is doing (and not how).
21. Bill of Lading clause: A particular article, stipulation or single proviso in a Bill of Lading. A clause can be standard and can be	 Business process redesign (BPR): The process of redesigning business practice models including the exchange of data and services amongst the stakeholders (i.e., finance, merchandising, production, distribution) involved in the life cycle of a chert's product.
preprinted on the BoL. 22. Bill of Material: A list of all parts, subassemblies and raw materials that constitute a particular assembly, showing the quantity of	amongst the stakeholders (i.e., finance, merchandising, production, distribution) involved in the life cycle of a chent's product. 30. Call: The visit of a vessel to a port.
each required item.	31. Call sign: A code published by the International Telecommunication Union in its annual List of Ships' Stations to be used for the
 Boat: A small open-decked craft carried aboard ships for a specific purpose, e.g., lifeboat, workboat. Bonded: The storage of certain goods under charge of customs viz. customs seal until the import duties are paid or until the goods 	information interchange between vessels, port authorities and other relevant participants in international trade. Note: The code structure is based on a three-digit designation series assigned by the ITU and one digit assigned by the country of registration. (PDHP = P&O NedByd Rotterdam)
are taken out of the country. (a) Bonded warehouse (place where goods can be placed under bond).	(r prim = r neo reconside nonseconfili)
(b) Bonded store (place on a vessel where goods are placed behind seal until the time that the vessel leaves the port or country	
again). (c) Bonded goods (dutiable goods upon which duties have not been paid, i.e., goods in transit or warehoused pending customs	
clearance). 25. Box: Colloquial name for container (e.g., Box-club).	
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 Cargo: (a) Conde transported as to be transported all goods carried on a chip accurated by a Del. 	/	39. Consignment instructions: Instructions from either the seller/consignor or the buyer/consignee to a freight forwarder, carrier or his agent, or other provider of a service, enabling the movement of goods and associated activities. The following functions can be
 (a) Goods transported or to be transported, all goods carried on a ship covered by a BoL. (b) Any goods, wares, merchandise, and articles of every kind whatsoever carried on a ship, other than mail, ship's stores, ship's spare parts, ship's equipment, storeger material, crev's effects and passengers' accompanied bagzage. 		covered: Movement and handling of goods (shipping, forwarding and stowage).
space parts, singly sequipment, stowage material, trew sciences and passengers accompanied baggage. (c) Any property carried on an aircraft, other than mail, stores and accompanied or mishandled baggage. Also referred to as 'goods'.		Customs formalities.
33. Carrier: The party undertaking transport of goods from one point to another.		Distribution of documents.Allocation of documents (freight and charges for the connected operations).
34. Cell: Location aboard a container vessel where one container can be stowed.		 Special instructions (insurance, dangerous goods, goods release, additional documents required). Containing to item of antiments as defined but to laterative Domenication for Standardization (USO) for temperature responses.
35. Cell position: The location of a cell aboard of a container vessel identified by a code for, successively, the bay, the row and the tier, indicating the position of a container on that vessel.	,	40. Container: An item of equipment as defined by the International Organization for Standardization (ISO) for transport purposes. It must be:
36. Cellular vessel: A vessel, specially designed and equipped for the carriage of containers.		 (a) a permanent character and accordingly strong enough to be suitable for repeated use; (b) specially designed to facilitate the carriage of goods, by one or more modes of transport, without intermediate reloading;
 Consignee: The party such as mentioned in the transport document by whom the goods, cargo or containers are to be received. Consignment: A separate identifiable number of goods (available to be) transported from one consigner to one consigner via one or 	r	 (c) fitted with devices permitting its ready handling, particularly from one mode of transport to another; (d) so designed as to be easy to fill and empty;
more than one modes of transport and specified in one single transport document.		(c) so designed as to be easy to in an empty,(e) having an internal volume of one cubic meter or more.
		41. Container chassis: A vehicle specially built for the purpose of transporting a container so that, when container and chassis are assembled, the produced unit serves as a road trailer.
		42. CFS: Container freight station: A facility at which (export) LCL (less than container load) cargo is received from merchants for loading (stuffing) into containers or at which (import) LCL cargo is unloaded (stripped) from containers and delivered to
		merchants.
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43. CLP: Container load plan: A list of items loaded in a specific container and where appropriate, their sequence of loading.	_/	52. Fully cellular container ship: Abbreviation: FCC. A vessel specially designed to carry containers, with cell-guides under deck and
44. Container logistics: The controlling and positioning of containers and other equipment.	1	necessary fittings and equipment on deck. 53. Full container load: Abbreviation: FCL.
45. Container manifest: The document specifying the contents of particular freight containers or other transport units, prepared by the party responsible for their loading into the container or unit.		(a) A container stuffed or stripped under risk and for account of the shipper and/or the consignee.
46. Container moves: The number of actions performed by one container crane during a certain period.		(b) A general reference for identifying container loads of cargo loaded and/or discharged at merchants' premises. 54. Grid number: An indication of the position of a container in a bay plan by means of a combination of page number, column and
 Container pool: A certain stock of containers which is jointly used by several container carriers and/or leasing companies. Container ship: A vessel, i.e., a floating structure designed for the transport of containers. 		line. The page number often represents the bay number.
49. Container stack: Two or more containers, one placed above the other, forming a vertical column.		55. Hatch cover: Watertight means of closing the hatchway of a vessel. 56. Hatch way: Opening in the deck of a vessel through which cargo is loaded into, or discharged from the hold and which is closed by
50. Container terminal: Place where loaded and/or empty containers are loaded or discharged into or from a means of transport.		means of a hatch cover. 57. LCL: Less than container load.
 Container yard: Abbreviation: CY. A facility at which FCL traffic and empty containers are received from or delivered to the Merchant by or on behalf of the Carrier. 		58. Merchant: For cargo carried under the terms and conditions of the Carrier's Bill of Lading and of a tariff, it means any trader or
		persons (e.g., Shipper, Consignee) and including anyone acting on their behalf, owning or entitled to possession of the goods. 59. Reefer container: A thermal container with refrigerating appliances (mechanical compressor unit, absorption unit, etc.) to control
		the temperature of cargo.
		60. Etceteral
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Interprimments Terminology Interaction al Information and Information	Ħ	0.2.4 Systematic Haration Initial Viewing View
• The "moral" of the above three examples is the composite of:	_/	Systematic Narration
\star a real domain description is long;	1	Systematic Partation
\star a real requirements prescription is long; and		• From the rough sketches of requirements to a
\star a real terminology is long.		\star properly expressed,
		\star consistent,
• In a textbook we can only hint at, but not illustrate, the real size of		\star relatively complete and
our descriptions, prescriptions and specifications.		* well-structured
		requirements document,
		• there is still a long way to go in order to
		• cover all relevant aspects, here called facets,
		• of the requirements.
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• It is the purpose of the next lecture parts to overview		Topic 54
\star proper structures,		Business Process Reengineering Requirements
\star proper principles and		
\star proper prescription techniques,		Characterisation 19.209 By business process reengineering we
• for attaining such well-designed requirements documents.		understand
• for attaining such wen-designed requirements documents.		• the reformulation of previously adopted business process
		descriptions,
		\bullet together with additional business process engineering work
		• Business process reengineering (BPR) is about <i>change</i> ,
		• and hence BPR is also about <i>change management</i> .
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Mart J T Page 1583. Topic: 54, Fol: 2 Risked Present Plank, DC:000 Fog-topic forwat	6. Before implementing a process in the real world create a
Michael Hammer's Ideas on BPR	laboratory version in order to test whether your ideas work.
1. Understand a method of reengineering before you do it for	7. You must reengineer quickly.
serious. 2. One can only reengineer processes.	8. You cannot reengineer a process in isolation. Everything must
3. Understanding the process is an essential first step in	be on the table.
reengineering.	 Reengineering needs its own style of implementation: fast, improvisational, and iterative.
4. If you proceed to reengineer without the proper leadership, you are making a fatal mistake.	 Any successful reengineering effort must take into account the personal needs of the individuals it will affect.
5. Reengineering requires radical, breakthrough ideas about process design.	
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What Are BPR Requirements?	* An enterprise wishes to improve operations by redesigning the
what Are BFR Requirements :	way staff operates within the enterprise and the way in which
• Two "paths" lead to business process reengineering:	customers and staff operate across the enterprise-to-environment
$\star {\rm A}$ client wishes to improve enterprise operations by deploying	interface.
 new computing systems (i.e., new software). In the course of formulating requirements for this new computing system 	 In the course of formulating reengineering directives a need arises to also deploy new software, for which requirements therefore have to be enunciated.
\diamond a need arises to also reengineer the human operations within	• One way or the other, business process reengineering is an integral
and without the enterprise.	component in deploying new computing systems.
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Overview of UPP Operations Overview of BPR Operations The other operations The other operations • We suggest six domain-to-business process reengineering operations: 1. introduction of some new and removal of some old intrinsics; 2. introduction of some new and removal of some old support technologies; 3. introduction of some new and removal of some old management	13.1 Overview of BPR Operation April 5.2006, 13.05 Page 1588, Taple: 54, Fab 7 The operation of the operation o
Device of BPR Operations The state of	13.1 Overview of BPR Operation April 5.2006, 13.05 Page 1588, Taple: 54, Fab 7 The operation of the operation o
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Between the spectrum of the spe	a) 1 decimal of generating the decimal
<form> Implementation of some new and removal of some old intrinsics; 0. introduction of some new and removal of some old support technologies; 3. introduction of some new and removal of some old management and organisation substructures;</form>	• (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
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• As the DDD negripance apts (makerills) the human as a cost	home(db)/all(Jabl)/Jablei April 5.2006,1105 Page 552, Tapic 54, Fab 11 Bitter Proven Pai, 67.300 Partyala, Donas
• As the BPR requirements "rebuilds" the business process / description part of the domain description ¹⁸ ,	• There are basically two ways of "rebuilding"
• and as the BPR requirements are not directly requirements for the	* the domain description's business process's description part (D_{BP})
machine,	★ into the requirements prescription part's BPR requirements
• we find that they (the BPR requirements texts) can be simply put	(R_{BPR}) .
in a separate section.	\star Either
	\diamond you keep all of D as a base part in R_{BPR} ,
	\diamond and then you follow that part (i.e., $R_{BPR})$
	\diamond with statements, R'_{BPR} , that express the new business
	process's "differences"
	\diamond with respect to the "old" (D_{BP}) . \diamond Call the result R_{BPR} .
	Volati the result <i>RBPR</i> .
1 III far - 16 101 (1) (2) (2) (2) (2) (2) (2) (2) (2) (2) (2	- 16 GR 723; Far - 16 601 BR1 E Dan Tgana, Feshari, 11, DR 2001 Mata, Danada Feshari, akada Adama da Agamedipantan, dandigame kaji (10, mari ma da A
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* Or	Place in Formalisation Document
\diamond you simply rewrite (in a sense, the whole of) D_{BP} directly	
into R_{BPR} ,	• The above statements as how to express the "merging" of BPR
\diamond copying all of D_{BP} ,	requirements into the overall requirements document apply to the narrative as well as to the formalised prescriptions.
\diamond and editing wherever necessary.	
	• We may assume that there is a formal domain description, \mathcal{D}_{BP} ,
	(of business processes) from which we develop the formal prescription of the BPR requirements.
	prescription of the Differentiation.
25 121, Fax + 66 493 1214 Done Bjørne, Fredrej 11, DK-346 Halte, Denark Ersalte, delfens datade, kjørnettganst tan, denettganst tat, UR: vena/sen datad [*] /de	- 16 65 272, Far - 16 688 604 👔 Dans Ugers, Frederij II, 105-366 Heite, Denach E-maile, debinnet stat, skjenet genal inst. Anterlijsene kil 1981. som innet stat, de
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• We may then decide to	Intrinsics Review and Replacement
\star either develop entirely new descriptions of the new business	
processes, i.e., actually prescriptions for the business	Characterisation 19.210 By intrinsics review and replacement we understand an evaluation
reengineered processes, \mathcal{R}_{BPR} ;	
* or develop, from \mathcal{D}_{BP} , using a suitable schema calculus, such as the one in RSL , the requirements prescription \mathcal{R}_{BPR} , by suitable	• as to whether current intrinsics stays or goes, and
parameterisation, extension, hiding, etc., of the domain	• as to whether newer intrinsics need to be introduced
description \mathcal{D}_{BP} .	
. 5.	
5 22), Fac + ef 480 804 State Anna State	- 46 455 223, Fac + 66 453 824 3 Can Bjoner, Federal 11, DK 346 Hale, Danack E main: definent das di, bjonerhynd son, desekhjoner bis, 155, von inn das di
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Example 19.173 Intrinsics Replacement: A railway net owner	Support Technology Review and Replacement
on an analysis of the second many and many the second many	Characterisation 19.211 By support technology review and
changes its business from owning, operating and maintaining railway nets (lines, stations and signals) to operating trains. Hence the more	Characterisation 10.211 by support technology review all
nets (lines, stations and signals) to operating trains. Hence the more	replacement we understand an evaluation
	-
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of	• as to whether current support technology as used in the enterprise
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of that new company's intrinsics while the notions of trains and passengers need be introduced as relevant intrinsics.	• as to whether current support technology as used in the enterprise is adequate, and
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of that new company's intrinsics while the notions of trains and	• as to whether current support technology as used in the enterprise
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of that new company's intrinsics while the notions of trains and passengers need be introduced as relevant intrinsics. Replacement of intrinsics usually point to dramatic changes of the	 as to whether current support technology as used in the enterprise is adequate, and as to whether other (newer) support technology can better perform
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of that new company's intrinsics while the notions of trains and passengers need be introduced as relevant intrinsics. Replacement of intrinsics usually point to dramatic changes of the business and are usually not done in connection with subsequent and	 as to whether current support technology as used in the enterprise is adequate, and as to whether other (newer) support technology can better perform
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of that new company's intrinsics while the notions of trains and passengers need be introduced as relevant intrinsics. Replacement of intrinsics usually point to dramatic changes of the business and are usually not done in connection with subsequent and	 as to whether current support technology as used in the enterprise is adequate, and as to whether other (newer) support technology can better perform
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of that new company's intrinsics while the notions of trains and passengers need be introduced as relevant intrinsics. Replacement of intrinsics usually point to dramatic changes of the business and are usually not done in connection with subsequent and	 as to whether current support technology as used in the enterprise is adequate, and as to whether other (newer) support technology can better perform
nets (lines, stations and signals) to operating trains. Hence the more detailed state changing notions of rail units need no longer be part of that new company's intrinsics while the notions of trains and passengers need be introduced as relevant intrinsics. Replacement of intrinsics usually point to dramatic changes of the business and are usually not done in connection with subsequent and	 as to whether current support technology as used in the enterprise is adequate, and as to whether other (newer) support technology can better perform

6 Support Technology Review and Replacement Industry (Mathematic Multileg)	OFTWARE ENGALEERING: Domain, Requirements and Software Design Volume 3 Departed of Cospore Geno and Experision and Experision of Cospore Geno and Experisio
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 Example 19.174 Support Technology Review and Replacement: / Currently the main information flow of an enterprise is taken care of by printed paper, copying machines and physical distribution. All such documents, whether originals (masters), copies, or annotated versions of originals or copies, are subject to confidentiality. 	 The following business process reengineering proposal is therefore considered: * Specially made printing paper and printing and copying machines are to be procured, and so are printers and copiers whose use requires the insertion of special signature cards which, when used, check that the person printing or copying is the person identified on the card, and that that person may print the desired document.
• As part of a computerised system for handling the future information flow, it is specified, by some domain requirements, that document confidentiality is to be taken care of by encryption, public and private keys, and digital signatures.	 * All copiers will refuse to copy such copied documents — hence the special paper. * Such paper copies can thus be read at, but not carried outside the premises (of the printers and copiers). * And such printers and copiers can register who printed, respectively who tried
• However, it is realised that there can be a need for taking physical, not just electronic, copies of documents.	 to copy, which documents. * Thus people are now responsible for the security (whereabouts) of possible paper copies (not the required computing system).
451 EZ; For +6 483 801 © Don Bjenne Folding 13, 101 289 Holes, Dannak E maile delfonsdarde, ignorefigenetisen, danellijsene (s. 101, seur son da de/ di	rd 65 323 Far - 66 683 869 (C Dan Bjann, Fashiq II, Dr 368 Mah, Dannak E Anah, Albann Back, Spannelgand an, Andhjann Ba (B), mai mada da'
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• The above, somewhat construed example, shows the "division of	Management and Organisation Reengineering
labour" between the contemplated (required, desired) computing system (the "machine") and the "business reengineered" persons authorised to print and possess confidential documents.	Characterisation 19.212 By management and organisation reengineering we understand an evaluation
• It is implied in the above that the reengineered handling of documents would not be feasible without proper computing support.	• as to whether current management principles and organisation structures as used in the enterprise are adequate, and
 Thus there is a "spill-off" from the business reengineered world to the world of computing systems requirements. 	• as to whether other management principles and organisation structures can better monitor and control the enterprise
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Page 1601 (2618) 26184 April 5 2006, 1365 Page 1603, Topic 54, Fait 23 Baland Present Pair 0.6280 Fait Page 160, 1	homs/db/vall1/2ch19/3ch19-i April 5, 2006, 13.05 Page 1604, Topic: 54, Fail: 24 Robust Pearwork Plaik, Dir 200 Kal-suph Deseark
	• The men and demain requirements are mandating
Example 19.175 Management and Organisation Reengineering: / • A rather complete computerisation of the procurement practices of a company is	• The proposed domain requirements are mandating
A rather complete computerisation of the procurement practices of a company is being contemplated.	\star that all procurer forms disappear in their paper version,
A rather complete computerisation of the procurement practices of a company is being contemplated.Previously procurement was manifested in the following physically separate as	
 A rather complete computerisation of the procurement practices of a company is being contemplated. Previously procurement was manifested in the following physically separate as well as designwise differently formatted paper documents: requisition form, order form, purchase order, delivery inspection form, rejection and return 	 * that all procurer forms disappear in their paper version, * that basically only one, the procurement document, represents all phases of procurement, * and that order, rejection and return notification slips, and
 A rather complete computerisation of the procurement practices of a company is being contemplated. Previously procurement was manifested in the following physically separate as well as designwise differently formatted paper documents: requisition form, order form, purchase order, delivery inspection form, rejection and return form, and payment form. 	 * that all procurer forms disappear in their paper version, * that basically only one, the procurement document, represents all phases of procurement, * and that order, rejection and return notification slips, and payment authorisation notes,
 A rather complete computerisation of the procurement practices of a company is being contemplated. Previously procurement was manifested in the following physically separate as well as designwise differently formatted paper documents: requisition form, order form, purchase order, delivery inspection form, rejection and return form, and payment form. The supplier had corresponding forms: order acceptance and quotation form, delivery form, return acceptance form, invoice form, return verification 	 * that all procurer forms disappear in their paper version, * that basically only one, the procurement document, represents all phases of procurement, * and that order, rejection and return notification slips, and payment authorisation notes, * be effected by electronically communicated and duly digitally signed messages that represent appropriate subparts of the one,
 A rather complete computerisation of the procurement practices of a company is being contemplated. Previously procurement was manifested in the following physically separate as well as designwise differently formatted paper documents: requisition form, order form, purchase order, delivery inspection form, rejection and return form, and payment form. The supplier had corresponding forms: order acceptance and quotation form, delivery form, return acceptance form, invoice form, return verification form, and payment acceptance form. 	 * that all procurer forms disappear in their paper version, * that basically only one, the procurement document, represents all phases of procurement, * and that order, rejection and return notification slips, and payment authorisation notes, * be effected by electronically communicated and duly digitally
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Example 19.176 Rules and Regulations Reengineering:	Human Behaviour Reengineering
• Our example continues that of Example 11.144.	
• Assume now, due to reengineered support technologies, that interlock signalling can be made magnitudes safer than before, without interlocking.	Characterisation 19.214 Human Behaviour Reengineering: By human behaviour reengineering we understand an evaluation
 Thence it makes sense to reengineer the rule of Example 11.144 * from: In any three-minute interval at most one train may either arrive to 	• as to whether current human behaviour as experienced in the enterprise is acceptable, and
 A four initial with the second of the initial most one of the initial with the top of depart from a railway station. * into: In any 20-second interval at most two trains may either arrive to or depart from a railway station. 	• as to whether partially changed human behaviours are more suitable for the enterprise
• This reengineered rule is subsequently made into a domain requirements, namely that the software system for interlocking is bound by that rule.	· •
•	
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Example 19.177 Human Behaviour Reengineering:	
• A company has experienced certain lax attitudes among members	• On one hand, there is the engineering of the contents of rules and
of a certain category of staff.	regulations,
• The progress of certain work procedures therefore is reengineered,	• and, on another hand, there are
• implying that members of another category of staff are henceforth expected to follow up on the progress of "that" work.	\star the people (management, staff) who script these rules and
\bullet In a subsequent domain requirements stage the above reengineering	regulations, \star and the way in which these rules and regulations are
• leads to a number of requirements for computerised monitoring of the two groups of staff.	communicated to managers and staff concerned.
•	
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Characterisation 19.215 By script reengineering we understand	Example 19.178 Script Reengineering:
evaluation	\bullet We refer to Examples 11.147–11.149.
• as to whether the way in which rules and regulations are scripted and made known (i.e., posted) to stakeholders in and of the	• In the lecture notes these two examples are carried through to their "business process reengineering end", and thus
enterprise is adequate, andas to whether other ways of scripting and posting are more suitable	• they illustrated the description of a perceived bank script language.
for the enterprise	One that was used, for example, to explain to bank clients how demand/deposit and mortgage accounts, and hence loans,
•	"worked".
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	Once that last decision has been made in the affirmative, we, as
Discussion: Business Process Reengineering Who Should Do the Business Process Reengineering?	• Once that last decision has been made in the animative, we, as software engineers, can then apply our abstraction and modelling skills, and,
• It is not in our power, as software engineers,	• while collaborating with the former kinds of professionals,
\bullet to make the kind of business process reengineering decisions	• make the appropriate prescriptions for the BPR requirements.
implied above.	• These will typically be in the form of domain requirements, which
• Rather it is, perhaps, more the prerogative of appropriately educated, trained and skilled (i.e., gifted) other kinds of engineers or business people	are covered extensively in later lectures.
• to make the kinds of decisions implied above.	
• Once the BP reengineering has been made, it then behooves the client stakeholders to further decide whether the BP reengineering shall imply some requirements, or not.	
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General	Topic 55
• Business process reengineering is based on the premise	Domain Requirements
• that corporations must change their way of operating,	Characterisation 19.216 By domain requirements we
• and, hence, must "reinvent" themselves.	understand
• Some corporations (enterprises, businesses, etc.) are	• requirements which are expressed
\star "vertically" structured	\bullet solely in terms of domain phenomena and concepts
\diamond along functions, products or geographical regions.	
\star Others are "horizontally" structured	
♦ along coherent business processes.	
★ In either case adjustments may need to be made as the business (i.e., products, sales, markets, etc.) changes.	
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Description Aut 1 2006 113 Tage 1810 Tage 1 50 FeB 2 The automation of domain. • So in setting out, initially, acquiring (that is, eliciting or "extracting") requirements, • the requirements engineer naturally starts "in" or "with" the domain. • That is, the requirements engineer asks questions, of the stakeholders, that eventually should lead to the formulation of domain requirements. • The structuring of these questions — it is strongly suggested — should follow • the structuring and contents of the domain facets description of the domain model, and • the five kinds of domain-to-requirements operations outlined next and treated in some depth in the following. VEXE VEXENT Vext 1 Structure Tage 2 Structure	<form><form><form></form></form></form>

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• In later in this lecture we shall treat a number of domain	• that is, are based upon, the entire domain description.
requirements facets.	• That is, the domain requirements represent a kind of "rewrite"
 ★ Each of whichever you decide to focus on, ★ in any one requirements development, 	• of the domain description.
* many one requirements development, * must be prescribed.	
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• Whether this "rewrite" is done one way, or another way,	• Either
• for that we cannot really state any hard principles.	* you keep all of D as a base part (R'_{DR}) in R_{DR} ,
• It all depends, so much, on the subject domain and the subject	* and then you follow that part (i.e., R'_{DR})
requirements.	\star with statements, $R_{DR}^{\prime\prime}$, that express the new business process's
• There are basically two ways of doing the "rebuilding"	"differences"
\bullet of the domain description's non-business process description part (D^{19})	* with respect to the "old" (D) . * Call the result R_{DR} .
• into the requirements prescription part's domain requirements (R_{DR}) ,	
• and that is as follows:	
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(vi) human behaviour parts	
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• Or	Place in Formalisation Document
\star you simply rewrite (in a sense, the whole of) D directly into	• The above statements as how to express the "rewrite" of
R_{DR} ,	requirements into the overall requirements document applies, in
\star copying all of D ,	particular, to narrative prescriptions.
\star and editing wherever necessary.	• But as we shall see, it also applies to formal prescriptions.
	• We may assume that there is a formal domain description, \mathcal{D} , from
	which we develop the formal prescription of the domain
	requirements.
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163 129, Far +6 683 1814 © Dien Rjamer Fricherj 11, DS 368 1846, Dannak Ernsch deffens duch Sporerfignal son, dem Rjamer 16 (161, was ins. duch./r.ds	- 16 653 252, Fac - 16 688 887 () Done Speen, Franke, 11, 20 588 840, Dennet Enterh defendent de SpeenSpeen an, dondigues in (M. encodende) d
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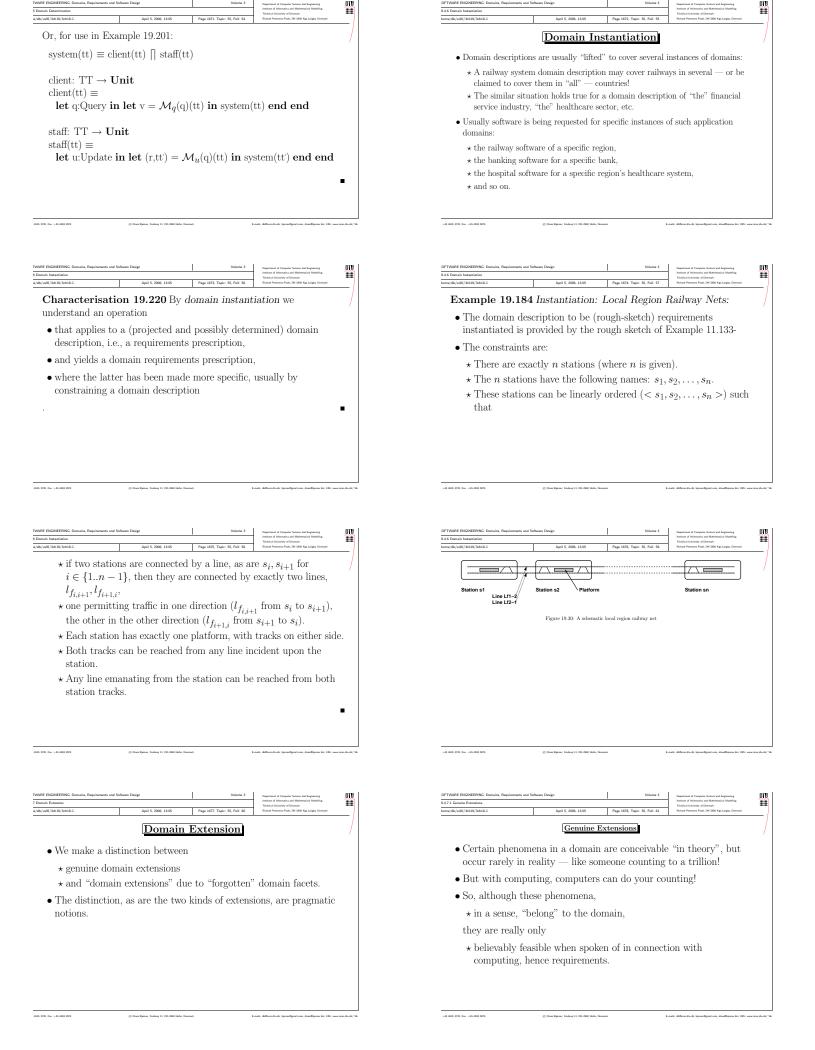
ARE EVCMEERING, Danakes, Regularements and Schware Darige UNI Domain Exception of Comparison of Com	OFTWALE ENCINEERIC Density, Regularements and Schware Design Volume 3 Department of Compare Scalar Design Volume 3 Regularements and Schware Design Volume 3 Regularement of Compare Scalar Design Volume 3 Regularem
• Airline customers, clients, in general, only wish to inquire a timetable (so we will here omit treatment of more or less	Specifically designated airline staff may, however, in addition to what a client can do, update the timetable.
 "malicious" or destructive acts). But you could still count the number of digits "7" in the timetable, and other such ridiculous things. So we postulate a broadest variety of inquiry functions, qu:QU, 	 But, recalling human behaviours, all we can ascertain for sure is that update functions, up:UP, apply to timetables and yield two things: another, replacement timetable, tt:TT, and a result, res:RES, such as: "your update succeeded", or "your update did
that apply to timetables, tt:TT , and yield values, val:VAL .	not succeed", etc.
	• In essence this is all we can say for sure about the domain of timetable creations and uses.
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• We can view the domain of the	scheme Tl_TBL_0 =
\star timetable,	class type
★ clients and	TT, VAL, RES
* staff	$\begin{aligned} \mathbf{QU} &= \mathbf{TT} \rightarrow \mathbf{VAL} \\ \mathbf{UP} &= \mathbf{TT} \rightarrow \mathbf{TT} \times \mathbf{RES} \end{aligned}$
• as a behaviour	value client_0: TT \rightarrow VAL, client_0(tt) \equiv let q:QU in q(tt) end
* which nondeterministically alternates ($[]$) between	staff_0: TT \rightarrow TT × RES, staff_0(tt) \equiv let u:UP in u(tt) end
 ★ the client querying the timetable client_O(tt), ★ and the staff updating the same staff_O(tt). 	${\rm tim_tbl_0:}~{\rm TT} \to {\bf Unit}$
and the order apparance the same order of (c).	$\begin{array}{l} tim_tbl_0(tt) \equiv & \\ (\mathbf{let} \ v = client_0(tt) \ \mathbf{in} \ tim_tbl_0(tt) \ \mathbf{end}) \\ & \prod (\mathbf{let} \ (tt', r) = staff_0(tt) \ \mathbf{in} \ tim_tbl_0(tt') \ \mathbf{end}) \end{array}$
223, Far. + 6 688 824 © Dave Space, Fachel II, DS 368 884 do Dava 4 Each & Each & Bellonder, SpaceSpacing, Another Sci UK, son in Ar. A' A	-eff 65 270, Tex +ef-681 601 🔅 Olim Speer, Fashing 11, DS-386 Hab, Danask E. Kush, & Speerdynal and, Sandhyner bir (95, searching 2), of a star of the star of th
	¹⁹ The nondeterminism referred to is internal in the sense that no outside behaviour influences the choice.
AME ENCADEERIG Downess, Registriments and Schwam Dasign Volume 3 Department of Cargons Science and Expansing URU Immun Projection Control Con	OFTWARE ENCARCERNG. Domains, Requirements and Saftware Design Violance 3 Department of Comparison of
Domain Projection	Characterisation 19.218 By domain projection we understand
• Usually	an operation • that applies to a domain description
\star the $span$ of the requirements is far "narrower"	• and yields a domain requirements prescription.
\star than the scope of the domain.	• The latter represents a projection of the former
• That is,	• in which only those parts of the domain are present
\star the conceived or actually described domain	• that shall be of interest in the ongoing requirements development
★ covers phenomena and concepts	
 ★ that will not be of concern ★ when constructing requirements for some particular application. 	
 We shall therefore have to explicitly express a "projection". 	
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• In a sense, of course, the document resulting from a domain	April 5, 200, 1205 Page 15, 200, 1205 Page 165, 100 Strength and remaining out of the strength and remaining
projection is still a domain description,	Example 19.180 Projection of Airline Timetable and Air Space:
 but — for pragmatic reasons — we shall refer to it as a domain requirements prescription. 	• We start out by formulating a <i>rough-sketch domain description</i> for the subdomain of airline timetables:
contait requirements preseription	\star There are airports, and one can fly between certain airports.
	\star There are airlines, and an airline offers flight services between
	\star There are airlines, and an airline offers flight services between such airports and at certain times.
	\star There are airlines, and an airline offers flight services between
	 ★ There are airlines, and an airline offers flight services between such airports and at certain times. ★ These services are recorded in an airline timetable. It lists

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nýdhývall/3k19/kb19-li April 5, 2006, 13.05 Pager 1639, Topic: 55, Fol: 22 Rituel Persues Pade, Dr-300 Kpi.1-pdp, Devnak		Technicul University of Densext Technicul University of Densex
\star There is the air space. It consists	_ /	scheme AIR_TT_SPACE =
 ♦ of airports, 	1	extend TLTBL0 with
 ♦ of air corridors (zero, one or more between pairs of airports), 		class
		type
♦ and of controlled areas around airports where the flight of airport is apacially provide and partial controlled) by		AS, Airport, Air_Corridor, Controlled_Area, ATC
aircraft is specially monitored (and partly controlled) by		no, mipore, miconneol, controlled nea, mic
\diamond air traffic control centres.		end
		Circ
-615 220; Fac: +64 680 001 🛞 Elsen Agreen, Festing 11, DK-2009 Halos, Dennak E-main: dedition disa, hjørne Agreen Agreen biz: UR: un	wimm.dtu.dk/*db	-46-465 220, Fac: +46-468 001 © Disse Bjenne, Feshing 11, 56-380 Helm, Domash E-maile: dollorin dau de, hjorendigunal cam, develhjoren kit, 161, sowi inn dau de
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• Now to a rough-sketch domain projection prescription:		We have taken the liberty, above, in AIR_TT_SPACE, not to model the
· · · · ·	/	details of timetables and the air space.
\star From the above we leave out any description of the air space.		•
\star That is, we project "away"		• You may rightfully claim that the above example was
\diamond air corridors,		• construed so as to fit the idea of projection.
\diamond controlled areas and		• •
\diamond air traffic control centres.		\bullet That may be so. But the idea has been demonstrated, has it not?
\star We leave the details to the student.		
scheme TI_TBL_1 = TI_TBL_0		
455 120), Fac: +6 688 8214 (2) Disse Egenes, Finduaj 11, DF-2040 Malte, Dennak E-maile: deBinnes, fuelogi and esereBjennes kij: UR: une	w imm dta dk/"da	:+66 655 3202, Fac: +66 668 8204 (i) Direct Egener, Feeding 11, DK-3869 Hilts, Dennak E-mail: differendus.dt, hjererdiparal.com, dordhjener hit UK: www.inn.dta.dt
TWARE ENGINEERING: Domains, Requirements and Software Design Volume 3 Department of Computer Science and Engineering	DTU	OFTWARE ENGINEERING: Domains, Requirements and Software Design Volume 3 Department of Computer Science and Engineering DTU
4.2 A General Example Indiced of Minimum 24 Mathematical Modeling Tachical University of Demark w/db/voll1/3ch10/3ch10-iii April 5,2006, 13:05 Page 1643, Topic: 55, Fol: 26 Rotade Pannes Paul, ROX00 KqLingly, Demark	Ħ	9.4.4.2 A Genaral Example Indited # Memoria M Material Multiling Technical University # Material Multiling Technical University
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A General Example	_ /	• Whereas observer (and functions defined on the basis of observer)
• It is terminal to have contain a demain description		functions are just postulated,
• It is typical to have sorts in a domain description.		• the projected observer (etc.) functions prescribe functions that
• Once these are projected onto the requirements they change		must be implemented.
\star from being abstractions of phenomena		• To make that distinction clear we may choose to rename these
\star to being concepts of these.		• To make that distinction clear we may choose to rename these functions.
		runctions.
* The former are descriptions, informal or formal, of "things out		
there", in the domain.		
\star The latter are prescriptions, informal or formal, of "things in		
there", in the software to be built!		
403 202, Ea. +6 493 504 © Dine Bjører, Freinel II, Dir 200 Hilts, Dennak E-ensis: dellenerite.de, igeneeligend con, denetligene izu UK. ve	winne dia di 1746	- efe 403 372, Fac: +64 401 4014 💿 Direct Barrer, Frederic II, Dot 3340 Heir, Danak Granic de directo de dire
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Example 19.181 From Domain Sorts to Requirements Sorts, I:		type
		N, S, J, Si, Ji
• A transport net consists of segments and junctions		value
		obs_Ss: $N \rightarrow S$ -set
\bullet such that every segment is connected to exactly two distinct		obs_5s: $N \rightarrow 5\text{-set}$ obs_Js: $N \rightarrow J\text{-set}$
 such that every segment is connected to exactly two distinct junctions 		
junctions		$obs Si S \rightarrow Si$
junctionsand such that to every junction there is connected one or more		obs_Si: $S \rightarrow Si$ obs_Ii: $I \rightarrow Ii$
junctionsand such that to every junction there is connected one or more segments.		obs_Ji: J \rightarrow Ji
junctionsand such that to every junction there is connected one or more segments.Thus from a transport net one may observe its segments (e.g.,		obs_Ji: $J \rightarrow Ji$ obs_Ji: $S \rightarrow Ji$ -set
junctionsand such that to every junction there is connected one or more segments.		obs_Ji: J \rightarrow Ji
junctionsand such that to every junction there is connected one or more segments.Thus from a transport net one may observe its segments (e.g.,		obs_Ji: $J \rightarrow Ji$ obs_Ji: $S \rightarrow Ji$ -set
junctionsand such that to every junction there is connected one or more segments.Thus from a transport net one may observe its segments (e.g., street segments) and junctions (e.g., street intersections).		obs_Ji: $J \rightarrow Ji$ obs_Ji: $S \rightarrow Ji$ -set
 junctions and such that to every junction there is connected one or more segments. Thus from a transport net one may observe its segments (e.g., street segments) and junctions (e.g., street intersections). To achieve a proper, consistent and complete net description we 		obs_Ji: $J \rightarrow Ji$ obs_Ji: $S \rightarrow Ji$ -set
 junctions and such that to every junction there is connected one or more segments. Thus from a transport net one may observe its segments (e.g., street segments) and junctions (e.g., street intersections). To achieve a proper, consistent and complete net description we will, most likely, have introduced the concepts of segment and 		obs_Ji: $J \rightarrow Ji$ obs_Ji: $S \rightarrow Ji$ -set
 junctions and such that to every junction there is connected one or more segments. Thus from a transport net one may observe its segments (e.g., street segments) and junctions (e.g., street intersections). To achieve a proper, consistent and complete net description we will, most likely, have introduced the concepts of segment and junction identifications — and related, via axioms, segments, 		obs_Ji: $J \rightarrow Ji$ obs_Ji: $S \rightarrow Ji$ -set

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axiom	• We can annotate the above axioms, line by line:
\forall s:S · card obs_Jis(s)=2 \land	
$ \forall n:N, s,s:S \cdot \\ \{s,s'\} \subseteq obs.Ss(n) \land s \neq s' \Rightarrow obs.Si(s) \neq obs.Si(s') \land $	 * (1) Each segment is connected to exactly two distinct junctions. * (3) Two segments of a net, if distinct, have distinct segment
$s \in obs_Ss(n) \Rightarrow $ $let \{ji,ji'\} = obs_Jis(s) in$	identifications.
$ \exists j_ij:J \cdot \{j_ij\} \subseteq obs_Js(n) \land ji=obs_Ji(j) \land ji=obs_Ji(j) end \land \forall j:J \cdot card obs_Sis(j) \ge 1 \land $	\star (4–6) For every segment of a net one can observe the identifications of two junctions — and these identifications must
\forall n:N, j.j':J · (i, i) \subseteq the L(i) A i (i') - the L(i) (the L(i') A	be those of junctions of the net.
$\begin{array}{l} \{j,j'\} \subseteq obs_Js(n) \land j \neq j' \Rightarrow obs_Ji(j) \neq obs_Ji(j) \land \\ j \in obs_Js(n) \Rightarrow \end{array}$	\star (7) Each junction is connected to one or more distinct segments.
$\begin{array}{l} \mathbf{let} \ sis = obs.Sis(j) \ \mathbf{in} \\ \forall \ si:Si \cdot si \in sis \Rightarrow \exists \ s:S \cdot s \in obs.Ss(n) \land si=obs.Si(s) \ \mathbf{end} \end{array}$	\star (9) Two junctions of a net, if distinct, have distinct junction identifications.
	\star (10–12) For every junction of a net one can observe the identifications of one or more segments — and these
	identifications must be those of segments of the net.
228, Faz. + el-484 60% 😪 Dinne Egener, Franke (L. D. 200 Febra Danace) E-ande Adfranzalo de sporteficario de antificare bio UK, service des de/~ de	- el 453 202 far - el 468 804 O Sour Spece Fasher (L. DC-368 Alb, Danask Evansk delton da de SpeceSpecifican, Andhyne biz US, war son da de
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A General Example Technical at Monitoria at	0.4.4.2 A General Example Technical Mathematical Mathemat
The annotation of the formalisation is really part also of the informal / narrative description.	Example 19.182 From Domain Sorts to Requirements Sorts, II:We continue Example 19.181.
	• In this example we may decide to project all that is described in Example 19.181.
 Domain projection now considers which * entities: sorts and values, 	• This means that nets, their segments and junctions shall be represented in the required software.
\star axioms relating these,	• This also means that segment and junction identifiers shall be represented in the
★ functions: observer functions, etc., ★ events and	required software. • Whereas the nets, segments and junctions (i.e., their descriptions) were (models
* events and * behaviours	of) real phenomena in the domain,
• are to be represented, somehow, in the required software.	\bullet the net, segment and junction prescriptions are models of the required software.
······································	
122, Far. 164 181 1871 Canil Game Grand, Franka (1, 26 366 Halo, Donard Canal) Canala differentia, Kjoneffgentian, daneffgentia, Kjoneffgentian, daneffgentia, Kjoneffgentian, daneffgentia, Kjoneffgentian, daneffgentia, Kjoneffgentian, daneffgentian, daneffgenti	- 16 655 123 far 16 683 103 () Com Upere, Fashing (), 05 306 Hilts, Danak E saide definition du de Haverbard and, definition du de Haverbard and, definition du de Haverbard and de Haverbard and definition du definita du definition du definition du definition du def
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• Observer functions become functions that must now be	type
implemented.	N, S, J, Si, Ji
• As such we may choose to rename them.	value
• Axioms are no longer axioms.	$\begin{array}{l} \operatorname{xtr}_{S:} N \to S\text{-}\mathbf{set} \\ \operatorname{xtr}_{J:} S: N \to J\text{-}\mathbf{set} \end{array}$
• They become invariants that must hold of any data structure	xtr_{SS} in \rightarrow 5-Set xtr_{Si} : $S \rightarrow Si$
representation of nets, segments and junctions.	xtr_Ji: $J \rightarrow Ji$
	$xtr_Jis: S \rightarrow Ji$ -set
	xtr Sis: J \rightarrow Si-set
22, Tar + 6 000 EDN © Diese Egneue, Frankey 11, DH 346 Main, Genarik Enable Address durch, SpeerAgned con, AnterBayer Ski UK, ann Inn An A ⁺ B	-el 803 203 far vel 603 201 💿 Dirac Rijana, Fashing H, Dir 200 Han, Danask E-andr Alfana, Bu, Spontfigues (an, Anthlynes (an, San Danash
Viels Bit Difference Strategie Australia Vielses 3 Oppose of Cognitive Strategie Strategi	OFTWARE EUROMEERING. Domains, Reprimensis and Schware Dasign Volumu 3 population of comos Coloura of Composition of Compositio
$wf_N: N \rightarrow Bool$ $wf_N(n) \equiv$	From Concepts to Phenomena
$\forall s: S \in xtr_Ss(n) \Rightarrow card xtr_Jis(s)=2 \land$	• The projection of the domain description of Example 19.181
$\forall s, s'.S \cdot \{s, s'\} \subseteq xtr_Ss(n) \land s \neq s' \Rightarrow xtr_Si(s) \neq xtr_Si(s') \land$	\bullet onto the domain requirements prescription of Example 19.182
$s \in xtr_Ss(n) \Rightarrow$	• reflects a subtlety:
$ let {ji,ji} = xtr_Jis(s) in $	* We may claim that the segment and junction identifications of
$\exists j,j':J \cdot \{j,j'\} \subseteq xtr.Js(n) \land ji = xtr.Ji(j) \land ji' = xtr.Ji(j) \land ji' = xtr.Ji(j) \land d \land $	Example 19.181 were mere concepts. * There may not have been any physically recognisable phenomena amounting
$\forall j, j': J \cdot$	* There may not have been any physicanty recognisable phenomena amounting to these identifications
$\begin{array}{l} \{j,j'\} \subseteq xtr_Js(n) \land j \neq j' \Rightarrow xtr_Ji(j) \neq xtr_Ji(j') \land \\ j \in xtr_Js(n) \Rightarrow \end{array}$	\star other than the — almost "law of nature" — fact that the mere
$j \in \operatorname{xtr}_{JS}(n) \Rightarrow$ let $\operatorname{sis}=\operatorname{xtr}_{SiS}(j)$ in	manifestations of two distinct segments and two distinct junctions
$\forall si:Si \cdot si \in sis \Rightarrow \exists s:Ss \in xtr.Ss(n) \land si=xtr.Si(s)$ end	amount to the unique identifications of all such segments and junctions.
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1225, Fai +16-1430 0074 © Dinne Rjanne, Fradourj II, Dir Jalo Hatz, Dumask E-maile diellinne drach, bjørnerðgenal com, dinneflijonne böz, UR. sveni inn dir dir / di	-46 405 520, Fair +46 468 4074 (c) Direc Rijner Jan (Finlan), Finlani, 11, 106 2040 Halta, Dennak Ernalit, deblenn dar de bjanerdynal con, denthijner bla (561, wewinne dar de

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Normal/DataBility/LabBility April 5: 2006, 13:05 Page 1605, Taple: 56, Feb. 38 Disturb Former Strate, 50: 2004 * There may thus not be any physically discoverable junction identifiers associated with segments (and segment identifiers associated with junctions). * * But it is clear that from junctions one can identify connected segments, and from segments one can identify the "end"	_/		-/
junctions.			
129, Far + 18 488 1831 💿 Dava Kjaner, Frankaj (L. Dil 2018 Mala, Davask E andr, definandarde, hysoendyparlane, develbywer bij, 143, soor	100 Br (A) ² B	-el 63 121 for +ti 681 121 () Gantigene fonder (1, Di 388 Male, Ganad. Encle differente de Spontigene aux dentigenes (1, Di 388 Male, Ganad.	1. dx. dx/
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• Often a domain exhibits <i>nondeterminism</i> , that is:	/	• Sometimes, for a requirements, the stakeholders may wish to remove such seeming uncertainty — nondeterminism, or looseness — as to some function results or some behaviours.	/
\star A function result or a behaviour can either be such and such \star or it can be such and such (different from the first such and		Characterisation 19.219 By domain determination we understand an operation	
such), \star or it can be such and such (different from the first two such and	l	 that applies to a (projected) domain description, i.e., a requirements prescription, 	
suches!). \star Or a function result or a behaviour can be <i>loose</i> (i.e., loosely		• and yields a domain requirements prescription,	
described):not all possible outcomes of a function application,or not all possible behaviours of a phenomenon		• where the latter has made deterministic, or specific, some function results or some behaviours of the former .	
may have been described, or even knowable.		- 46 63 707 for - 14 470 871 0 20m Bann Frederi U 09 308 Mah. Davist Enails Albandya A. Sperskyndian, Andelparabio (Kr. vers in	
EXERCISE One on a sequence of the first s			
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air Deterministion Initial Advances of Millinguing Milling air (Marking) Mallori April 5, 2006, 13.05 Page 1661, Tagie 55, Fail 44 • A rough-sketch timetable querying domain requirements	—	4.45 Domin Determination Interfed reference of the Interfed reference	н Н
description is:	,	extend TLTBL_1 with class	
 ★ There are given notions ♦ of departure and arrival times, and ♦ of airports, and 		type T, An, Fn	
♦ of airline flight numbers.		end	
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• A timetable consists of a number of air flight journey entries.	scheme $TI_TBL_3 =$
\star Each entry has a flight number,	extend TLTBL2 with
\star and a list of two or more airport visits.	class
\diamond an airport visit consists of three parts: An airport name, and a	$\mathbf{type} \\ \mathrm{JR}' = (\mathrm{T} \times \mathrm{An} \times \mathrm{T})^*$
pair of (gate) arrival and departure times.	$JR = \{ jr: JR' \cdot len jr \ge 2 \land \dots \}$
	$TT = Fn \ \overline{m} \ JR$
	\mathbf{end}
	We illustrate just one, simple form of airline timetable queries.
	• A simple airline timetable query
	\star either just browses all of an airline timetable,
	\star or inquires of the journey of a specific flight.
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• The simple	• The result of a query is a value:
\star browse query thus need not provide specific argument data,	\star the specific journey inquired,
\star whereas the flight journey query needs to provide a flight	\star or the entire time table browsed.
number.	• The result of an update is a possible timetable change
• A simple	\star and either an "OK" response if the update could be made,
\star update query inserts a new pairing of a flight number and a	\star or a "Not OK" response if the update could not be made:
journey to the timetable,	♦ Either the flight number of the journey to be inserted was
\star whereas a delete query need just provide the number of the flight	already present in the timetable,
to be deleted.	\diamond or the flight number of the journey to be deleted was not
	present in the timetable.
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operation	assume a projected and instantiated timetable (see Example 19.183).
• that applies to a (projected and possibly determined and instantiated) domain description, i.e., a (domain) requirements	• A query of a timetable may, syntactically, specify an airport of origin, a_o , an airport of destination, a_d , and a maximum number,
prescription,	n, of intermediate stops.
• and yields a (domain) requirements prescription.	• The query semantically designates the set of all those trips of one up to n direct air journeys between a_o and a_d , i.e., trips where the
• The latter prescribes that a software system is to support, partially or fully, an operation that is not only feasible but also computable in reasonable time	passenger may change flights (up to $n-1$ times) at intermediate airports.
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schemer TI_TBL_3C =	• The point about this example is that for n being just 4 or above, a / hand calculation is infeasible.
extend TLTBL.3 with class	• But a Prolog program of less than a dozen lines, when the basis
type Query' == Query mk_conn(fa:An,ta:An,n:Nat) VAL' = VAL CNS CNS = (JR*)-set	• But a Protog program of less than a dozen lines, when the basis for executions, will start producing results after very few seconds on most PCs, for example for n=5.
value $\mathcal{M}_q(\text{mk.conn}(\text{fa},\text{ta},\text{n})) \equiv \dots$	
end	
•	
SI 221, Fac + 64 681 801 © Divertifiener, Freiheig 11, DK-2048 Hiltor, Danack E-scale differendisch, SporeSporalizer, divertifipioner Mc URL wave interdisch / di	+6 62 22, Fac. +6 681 854 🛞 One Rjener, Frakej II, DK 388 Han, Danak E-main defendu de, hjenerlynal con, derethjener hij USI: nov-leve de de
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"Forgotten" Domain Descriptions	Example 19.186 A "Forgotten" Transport Net Domain
• Sometimes one forgets to describe some domain facet.	Description:
• The discovery that one (might) have forgotten such a facet is	• We continue Examples 19.181–19.182.
usually made during domain requirements prescription.A stakeholder requirements is such that the domain requirements	★ We have not equipped segments with attributes (such as lengths, geodetic (cadastral) coordinates, segment state of fitness (i.e., "need of repair"), or other).
engineer lacks a "socket", some text and possibly formulas in the	\star And we have therefore not described any functions that observe
domain description which can serve as a basis for projection, instantiation, determination and extension.	attributes, attribute values for given attributes, and, for
• An example may serve to focus the idea.	example, those segments of a net which possess attributes (A) of specified values (VAL).
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b/voll1/3ch10/2ch10+ii April 5, 2006, 13.05 Page 1665, Topic: 55, Fol: 68 Richard Promous Plank, DK-2000 Kg-Length, Dennak	homs/db/vell/3ch10/3ch
• We "discover" this general omission during the requirements gathering stage when stakeholders,	• So we extend the domain description of Example 19.181.
* for one set of requirements, express the requirement to offer	* With every segment we associate a finite, usually small number of attributes (that is, attribute names, $a : A$).
travellers shortest routes in nets, or,	* And with every attribute we associate a set of attribute values
1 1	$(v_1, v_2, \ldots; V).$
\star for another set of requirements, express the requirement to	Thus we are able to observe which attributes are accousted with
	★ Thus we are able to observe which attributes are associated with a given segment,
\star for another set of requirements, express the requirement to	a given segment, \star and, for that segment and an attribute of that segment, we are
\star for another set of requirements, express the requirement to	a given segment,
\star for another set of requirements, express the requirement to	a given segment, \star and, for that segment and an attribute of that segment, we are

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Talifazzi Danian Unterprotein April 5, 2006, 13:05 Page 1607, Topic: 55, Fol: 70 Robust Areas Page 1607, Topic: 55, Fol: 70 Robust Areas Page 1607, Topic: 55, Fol: 70 Robust Page 1607, Topic: 55, Fol: 70, Fol: 700, Fo	April 5, 2006, 13:05 Page 1688, Tapic: 55, Fall Thistial University of Densets
• Now we can express the further extensions:	type
* Assume ordering relations, \leq_{a_i} , one per attribute $a_i : A$, on	/* N, S, J, Si, and Ji as in Example 19.181 */
attribute values.	A, VAL
\star Now we shall require a function which, from a net, extracts all	value
those segments which for a given attribute have attribute values	obs_As: $S \rightarrow A$ -set
within a given range.	obs_A_VAL: $S \times A \xrightarrow{\sim} VAL$ pre obs_A_VAL(s,a): $a \in obs_As(s)$
	\preceq_a : VAL × VAL → Bool
	is_in_range: $S \times (A \times (VAL \times VAL)) \rightarrow \mathbf{Bool}$ is_in_range(s,(a,(v,v))) \equiv
	$v \preceq_a obs_A_VAL(s,a) \preceq_a v'$
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getter" Domain Descriptions III(Jah19/Jah19= April 5, 2006, 11.05 Page 1660, Topic 55, Fail: 72 Robert Description Advances Robert Description	9 A 7.2 "Drogstee" Domain Descriptions Textual of Mentical and Mentical Adding Textual of Descriptions Textual of Description
$\begin{array}{l} \operatorname{extract_Ss:} \ \mathrm{N} \times (\mathrm{A} \times (\mathrm{VAL} \times \mathrm{VAL})) \to \mathrm{S}\text{-set} \\ \operatorname{extract_Ss}(\mathrm{n}, (\mathrm{a}, (\mathrm{v}, \mathrm{v}))) \equiv \\ \{\mathrm{s} \mathrm{s:}\mathrm{Ss} \in \mathrm{obs_Ss}(\mathrm{n}) \wedge \mathrm{a} \in \mathrm{obs_As}(\mathrm{s}) \wedge \mathrm{v} \preceq_{a} \mathrm{obs_A}_\mathrm{VAL}(\mathrm{s}, \mathrm{a}) \preceq_{a} \mathrm{v}\} \end{array}$ The reader can extend the above to also cover junctions. •	• Once identified, "repairing" the description of a "forgotten" domain facet can either be thought of as a domain extension — and that is why we have placed the issue of "forgetfulness" in this section on domain extension — or it may prompt the requirements engineer to have the "original" domain description updated.
	• To keep in line with our treatment of the omission, we decide to handle the "repair" in the extension part of our domain requirements engineering.
	• Thus we have obviously decided to project the repaired domain facet onto the domain requirements prescription.
	• This first part of the domain extension is then to be followed by possibly further domain to requirements operations.
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• Often a domain being described	• that applies to two or more, say m , projected and possibly
"fits" onto, is "adjacent" to, "interacts" in some areas with,another domain:	• that applies to two of more, say <i>m</i> , projected and possibly determined, instantiated and extended domain descriptions, i.e., to two or more, say <i>m</i> , original domain requirements prescriptions,
\star transportation with logistics,	 and yields m + n (resulting, revised original plus new, shared) domain requirements prescriptions.
 ★ healthcare with insurance, ★ banking with securities trading and/or insurance, ★ and so on. 	• The m revised original domain requirements prescriptions resulting from the fitting prescribe most of the original (m) domain requirements.
	• The n (new, shared) domain requirements prescriptions resulting from the fitting prescribe requirements that are shared between two or more of the m revised original domain requirements
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Example 19.187 Shared Domain Requirements:	* Junctions also possess attributes: to which one or more segments they are connected, standard traversal time, standard traversal
• Let the domain be that of multi-modal transportation nets:	cost (which is a function of the entry and exit segments: if of the
\star A multi-modal transportation net has segments and junctions.	same segment modality then maybe the cost is zero whereas if of
 * Segments and junctions are uniquely identified. * Segments possess attributes: to which two junctions they are connected, length, standard traversal time, standard traversal cost, wear-and-tear (relevant for rail lines and roads), modality, and possibly other attributes. 	different segment modalities then it reflects the cost of transfer (unloading and loading), and the set of one or more modalities of the connected segments.
n + 4 (10) 8/h (2 films Figure / Films (2 films / Film	el 603 120, fm el 601 825 🔅 Don Spann, Facher II, Gr. 308 Main, Smooth Enach & Enach & Mann Audo, SpannSpack and, Anderspace St. 100, ann ann

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* One can speak of paths, from junction via a segment to a	• We outline two rough text original domain requirements.
connected junction, and routes — as sequences of connected paths.	\starA transportation net maintenance support system:
★ Hence one can speak of the longest route(s) and the shortest	\diamond The software package for this support system shall
standard traversal time between two junctions.	\diamond help rail line maintenance planners to identify
* One can also speak of best wear-and-tear quality route(s) also	\diamond segments (i.e., lines) in need of immediate repair (that is,
between two junctions.	corrective maintenance)
Section on anotono.	\diamond or scheduled preventive maintenance (that is inspection),
	\diamond and, when such has been effected to record the (new)
	wear-and-tear status of maintained segments.
	 These requirements imply further determination of segment attributes.
	♦ Etcetera.
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* A transportation net logistics support system:	• The shared domain requirements are the following:
◆ The software package for this support system shall	\star Nets consisting of segments and junctions, thus also
help combined road-rail travel planners	identification of segments and junctions;
♦ to identify combinations of one or more of	\star provision for segment attributes; and
• shortest length route(s),	\star ability to select segments of a given modality.
 shortest traversal time route(s), least costly route traversal(s), and/or	\bullet We leave it to the reader to formulate what is specific to the two
• route(s) with fewest transfers between transport modalities.	revised original domain requirements.
• Etcetera.	•
o Electera.	
1 220, Fac + 66 400 001 © Dires Bjøner, Frednej 11, DK-2000 Holte, Downań E-walic definenditude, bjereefipeal con, directifijorer bit, USL: www.ien.edu.dk/db	
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onuin Requirements Fitting histoira di bioincica di bioinci di bioincica di bioincica di bioincica di bioincica di bioinci	8 A 8 Domain Requirements Fitting Technology Models Technol Website of United States (State Free Street States) (State Free States) (State Free States) (State Free States) (States)
Example 19.188 Fitting of Passenger Transfers Between Busses	Rough sketches are as follows:
and Trains:	• The bus system consists of
• We assume that there are two domain requirements prescriptions,	v
\star one for metropolitan bus systems of bus lines, bus stops, etc., and	\star a set of bus lines, each being numbered and otherwise designated
	in a bus timetable,
\star one for railway systems of rail lines and stations.	* where this bus timetable, modulo "every" hour, for every bus
• We further assume that	line, specifies at which minutes ("past the hour") the bus stops at each stop of the line.
\star one of the prescriptions has been in existence for some time —	-
\star maybe even that an existing product is based on those	• After this there follow a number of other entity, function and
requirements —	possibly behaviour descriptions.
\star and that the other prescription is currently being developed.	
222, Far 16 488 2014 🔹 Ösen Bjører, Fankej II, D. 538 Hikh, Donard Erach, Alfone darde, Bjører Bjørel for blir, U.S. von inn die de "A	+6 65 22 far +6 683 834 💿 Dim Rjower, Fachelj 11, 05 380 Neb, Smoot
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main Requirements Fitting Technical Technical Mening Tech	9.4.8 Doniah Requirements Fitting Internet Status 2000 (1997) (19
scheme BUS =	• The railway system consists of
class	\star a set of train lines, each being numbered and otherwise
type	\star a set of train lines, each being humbered and otherwise designated in a train timetable,
BSn, BLn, Min	
$BTT' = BLn \overrightarrow{m} (BSn \times Min)^*$	* where this timetable, modulo "every" hour, for every train line specifies at which minutes ("past the hour") the train stops at
$BTT = \{ btt:BTT' \cdot wf_BTT(btt) \}$	specifies at which minutes ("past the nour") the train stops at stations of the line.
value	
wf_BTT: BTT \rightarrow Bool	• After this there follow a number of other entity, function and
	possibly behaviour descriptions.
end	

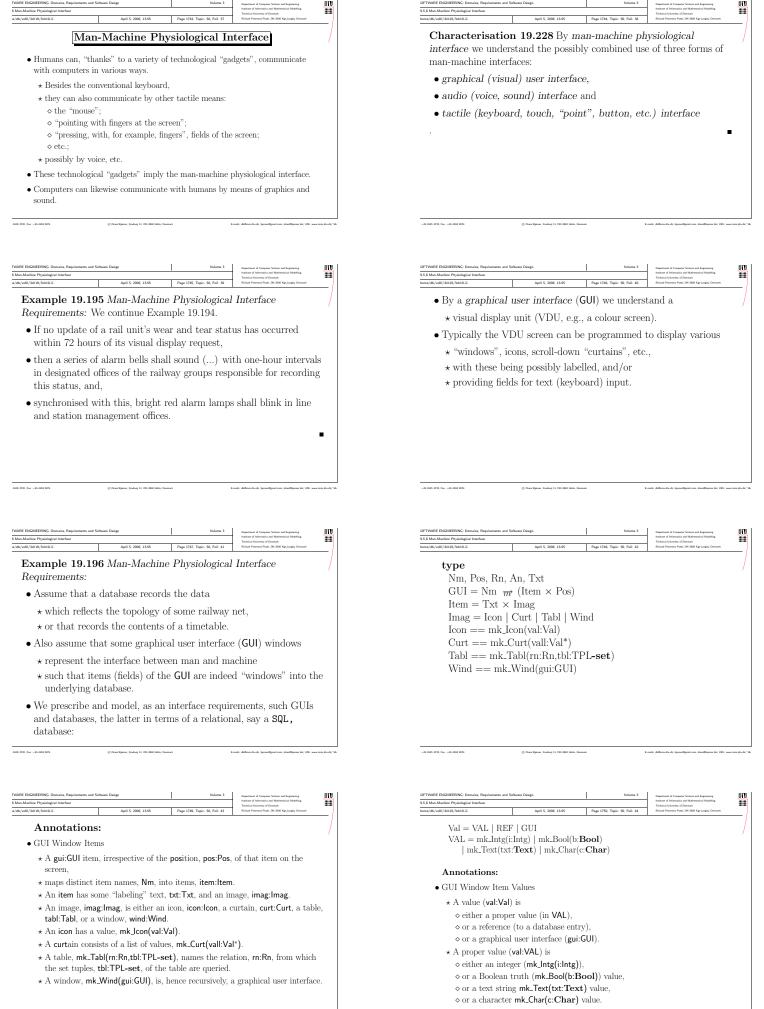
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m/db/voll/3ch19/3ch19-ii April 5, 2006, 13:05 Page 1703, Topic: 55, Fol: 86 Richard Permens Paul, DV-Sold KycLingle, Drivnak	homs(ds/vell1/dsh19/dsh39-ii Aprë 5,2006,13:05 Page 1704, Topic 55, Fol: 67 Kitae Poreau Paul, 05:2008 paj.upig, Denauk
scheme RAIL =	• Now the "fitting":
class	\star Certain stations (bus stops) are to be designated as bus (train)
type Sn, RLn, Min	transfer stations (bus stops).
$RTT = RLn \frac{1}{m} (Sn \times Min)^*$	* Passenger travel routes may include transfers at such stations
$RTT = \{ rtt: RTT' \cdot wf_RTT'(rtt) \}$	(bus stops) between buses and trains.
value	 After this there follows a number of other entity, function and possibly behaviour prescriptions.
wf_RTT: RTT' \rightarrow Bool	possibly behaviour prescriptions.
end	
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<pre>scheme BUS_RAIL = extend BUS_with extend RAIL with</pre>	Discussion: Domain Requirements
class	• We have outlined five reasonably distinguishable operations that
type	the requirements engineer may need perform in order to construct
Transfer' = Bsn \overline{m} Sn	a domain requirements prescription.
$Transfer = \{ tr:Transfer \cdot card dom tr = card rng tr \}$ value	• There may be other such operations.
	\bullet The above five have been found useful in several development
end	projects.
End of Example 19.188	• Knowing about them, their underlying principles, and their
End of Example 19.188	 techniques and tools should help the requirements engineer to more efficiently acquire domain requirements prescriptions, and to
	document them, i.e., to structure their documentation logically.
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Interface Requirements Technical University of Densak n/db/vell/Jch.19/	
Topic 56	• The term 'shared' is crucial.
Interface Requirements	• For "something" to be <i>shared</i> between the domain and the
	machine,
Characterisation 19.223 By interface requirements we understand	• that "something" must be present in the domain.
	\star It must be en entity, a function, an event or a behaviour
• those requirements that are expressed	\star which has been projected, instantiated, possibly made more
• solely in terms of such phenomena and concepts	deterministic, possibly extended and possibly fitted.
• that are <i>shared</i> between	
\star the domain and	
★ the machine.	
♦ The machine is the hardware to be prescribed and	
\diamond the software to be developed	
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• And that "something" must be present in the machine:	• The "something" is said to be a shared phenomenon cum
* Its attributes, including value, if an entity, must "somehow" be	concept.
more or less regularly monitored by (read in from the domain, or set by, output from the) machine.	• We use the "somehow" hedge to indicate to the course student that the interface requirements shall stipulate, shall prescribe that
set by, output from the) machine. * Its functionality, if a function, must somehow replace that	'somehow'!
* its functionality, if a function, must somenow replace that "present" in, or "co-opted", taken over from the domain,	• Shared phenomena cum concepts is what this section (Sect.) is all
* and its behaviour, if a behaviour, must somehow "simulate" the	• Shared phenomena cum concepts is what this section (Sect.) is an about!
behaviour of the domain, or	• The shared "things" are usually phenomena in the domain, but
\star its occurrence, if an event, must somehow be replicated: If in the	
domain, then recorded by the machine, and if in the machine,	shared.
then signaled to the domain.	
455 520, Fac: +45 4593 0274 (Chief Bigener, Fredory J1, DK-2005 Holts, Dennack E-mail: dolf-menduads, hjoren-Bgenal.com, diserbilgioner, bij: URL: www.in	n. dtu. dk/"db 🔅 Diese Rijmer, Fedorej 11, DK-2000 Haite, Demack E-maile: db/Benn dtu. dk, bjenner@genal.com, demo@bjenner. bie; URL: www.inem. dtu. dk/"db

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Example 19.189 Shared Phenomena:	Example 19.190 Shared Concepts:
• We may think of a train traffic monitoring and control system being interface requirements developed.	• We continue Example 19.189.
• The following phenomena are identified as among those being	• The following train traffic concepts are among those being
• The following phenomena are identified as among those being shared:	• identified as being shared:
* rail units,	 state of units, including whether a unit is open, closed, reserved, occupied, etc.,
* signals,	* routes (a route is, in general, not humanly visible (being often
\star road level crossing gates,	geographically widespread)), and hence open routes.
\star train sensors (optical sensor sensing passing trains) and	
* trains.	
•	
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Shared Phenomena and Concept Identification	• Whether and how to categorise these shared phenomena and concepts
• A crucial step of requirements development is therefore that of identifying,	\bullet is what the rest of this section on interface requirements is about.
• from among the many phenomena and concepts of the projected (etc.) domain	• Suffice it to state that we here expect that the requirements engineers —
• which of these are shared.	\bullet in close collaboration with requirements stakeholders —
• Examples 19.189 and 19.190 gave informal, rough-sketch examples.	• list these shared "things", and, along the road,
- Examples 19.109 and 19.109 Eave mornial, rough-sketten examples.	• while individually pursuing any one of the interface requirements
	facets, annotate this list with classifiers (whither one of the six interface requirements facets treated next, "where used", etc.).
	interface requirements facets treated fext, where used, etc.).
Far +6 483 821 © Dinn Kjane, Fishej Li, DK-384 Hab, Danak Fasik defines die defines die defines die definier die definier big Vik was inn die de/de	- 46 453 320, Fax - 46 483 8214 (2) Dans Egenery, Fashing 11, De 2016 Hitter, Donauk E-marks definendas de, ignorefiquei lans, disorditipante das 1981, sono dore
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Regulamente Facta Haller an Haller and Hall	9.5.2 Interfees Requirements Faceta home/db/vell/26315/iii Apr2 5, 2006; 13:05 Page 17:6, Topic 56, Foil: 10 Kitad Poisson Path. 05:202 Ket_spipe Desixt
Interface Requirements Facets	\bullet We for esee further identification of (i.e., other) interface
• We shall consider six kinds of interface requirements:	requirements facets than the six so far listed.
	 And we foresee an analysis, in the future, of some of the six listed facets into a more finely granulated set of (more or less) orthogonal
* shared data initialisation requirements, * shared data refreshment requirements,	interface requirements facets.
* computational data and control requirements,	• Suffice it now, for the purposes of this part of these lectures,
* man-machine dialogue requirements,	namely that of presenting basic principles and techniques of
\star man-machine physiological interface requirements, and	requirements engineering, to bring in just these six facets.
\star machine-machine dialogue requirements.	
Far vil 400 BER © Dine Eguns, Federal 11, 10:300 Halls, Danzak F	-66 455 2721, Fax +66 681 827 © Dim Kgawe, Fashing 11, 50-261 Mar, Danask E-sachi, Admonstration, Apare-Agnatione, Apareligiane 20, 151. seen Jace
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NGINEERROC Density, Registrements and Statues Design Values 3 Programment from the first three interface requirements facets motivate DIF • The first three interface requirements facets motivate • the need for the last three interface requirements facets. * Shared data generally reside in the domain and in the machine. * Computational data and control typically (but do not exclusively) reside in the human users who may interface with the machine during its computations, i.e., may interact with the	OTTOMER ENGINEETING: Duration, Requirements and Software Design Values 3 Dispersion of Compare Nature and Equipage Material Action of Compare Acti
CENEEERRG. Duratin. Requirements and Software Datage Values 3 Properties of Corpus Lines of Corpus Lines of Expanse. DID Requirements from: April 15.2006.13.05 Page 1072. Taple: 56.768.11 The first three interface requirements facets motivate The need for the last three interface requirements facets. * • The need for the last three interface requirements facets. * Shared data generally reside in the domain and in the machine. * • Computational data and control typically (but do not exclusively) reside in the human users who may interface with the machine during its computations, i.e., may interact with the	OTTORNE DISCRETING: Duration, Requirements and Software Design Values 3 Discrete of Graphs Notice and Expansing 65.2 Interface Requirements Frank Interface Requirements Frank Interface Requirements Frank Interface Requirements Frank • These first three interface requirements facets prescribe * what information shall (need to) be shared, * as well as some abstract principles according to which • the external domain information shall be communicated \$ into internal machine data

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(Minutification) Addition April 5.2006, 13.05 Page 1776, Taple: 56, Fab 13 Route Pressure True Direction Produced International Control Produced Internationa Control Pro	Interface Requirements and the Requirements Document
 * how that information concretely shall be communicated between > humans and/or > other machines (and equipment in general) * and the machine being requirements prescribed. • We now explain these six facets of interface requirements. • But first we bring in a brief aside. 	 Some remarks need to be made before we go into details of domain requirements modelling techniques.
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Requirements for "Input/Output"	Place in Narrative Document
• Interface requirements are about:	• Later in this lecture we shall treat a number of interface requirements facets.
 * "putting" part of the domain "inside" the machine. Interface requirements engineering is about * how to get parts of the domain into a machine (to become part of its state), from the domain, or from other machines; * and how to reflect [new, computed] states back into the domain, or onto other machines. Thus interface requirements are about shared (usually entity) phenomena and 	 * Each of whichever you decide to focus on, * in any one requirements development, * must be prescribed.
1612 EZ / For - 6 4181 EM © Dina Rijam Paska (1. Di 200 MA), Danaki TRUE EXCALEERING: Danalan, Regimmenta and Software Design Volum 3 13 Files in Regimmenta and Software Design Parka (1. Di 200 MA), Danaki 13 Files in Regimmenta and Software Design Volum 3 13 Files in Regimmenta (2. Di 200 MA), Danaki 14 Files Volum 3 14 Files Volum 4 15 Files in Regimmenta (2. Di 200 MA), Danaki 15 Files i	- 46 62 123, Far + 66 68 101 © Dans Speer, Falled II, DC-208 Halt, Dansek Evable Advance. A: SpeerApparties AdvAnparties (UK), was into AdvAnparties (UK),
• The interface requirements all take their "departure point", that is	• That is, the interface requirements represent a kind of
are based upon, * the entire domain description, * as well as potentially available machine input/output technology.	 * "merging" of some form of the domain description, * with descriptions of relevant, i.e., chosen, input/output technology.
	• The two "merged" descriptions become a prescription, the interface requirements prescription.
	• Since that "merge" was not present in the domain,
	\star the interface requirements prescription \star becomes an entirely new document part.
155 127, Yur + 6 601 1371 © Dire Rijane, Franka 11, Dr. 301 144a, Danak Exash didanadarah, YapenBijaralana dan Bijane Na Ula, wasi ina da da "da	+4 63 224 for +6 63 201 🖉 One Ngree, Falsey 11, 05 201 May, Sansak Earsh defendere, Nyarekged son, denktyree Ma Vit, was ten der, A 'A
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Utility/db/l/db/l/db/l/db/l/db/l/db/l/db/l/db/	Money (Me) (MII) (2630) 2630 433 April 5, 2006, 13.05 Page 1295, Tepic: 56, Fail: 30 Road Forward Paid, Oct.202 Reprinting Downlet We then develop an entirely new document,
• The above statements on how to express the interface requirements	• the interface requirements, $\mathcal{R}_{I/F}$.
also apply to formal interface requirements prescriptions.	• It somehow
• We may assume that there is	$\star \text{ "merges" parts of } \mathcal{D}$ $\star \text{ with parts of } \mathcal{D}_{IO}$
\star a formal domain description, \mathcal{D} (from which we develop parts of the formal prescription of the interface requirements),	• into the resulting $\mathcal{R}_{I/F}$.
 ★ and narrative descriptions of the input/output technologies. ★ We further assume that there are formal descriptions, D_{IO}, of these input/output technologies. 	This lecture on interface requirements is about the "merge" principles and techniques.
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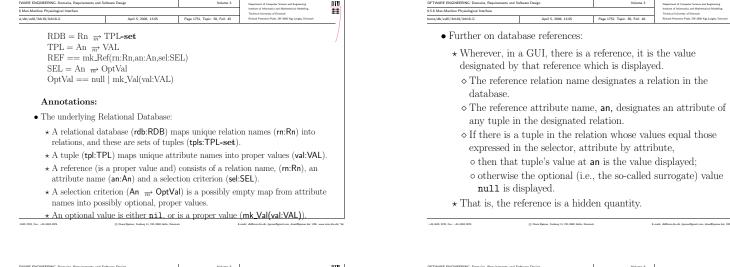
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delyvell()2h309/2h309 iii Apel 5 2006, 13:05 Page 1272, Topic 56, Fait 21 Richard Provider Fail, OK-2020 Facilityth, General Shared Data Initialisation	https://doi/10.1016/bill/bill/bill/bill/bill/bill/bill/bil
 Information that is shared between the domain and the machine is often nontrivial in its structure and extent. Special care must be taken to introduce such information to the	understand an operation that creates a shared data structure in the machine $$\cdot$$
machine.	
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REE ENCARCEESING Durnains, Regulamments and Software Design Volume 1 Department of response closes and Equating Indicate Information Difference of Information Informatio Information Informatio Information Informatio Informatio	OFTWARE ENGINEERING. Domains. Requirements and Software Danjos Valuema 3 Depresent of Corpus Science of Equinary Instance of Manazima Mathematica Material (Manazima Mathematica) Description of Equinary Instance of Manazima Mathematica Material (Manazima). Science of Equinary Material (Manazima). Science of Equinary Material (Manazima). Science of Equinary Mathematica Description of Equinary Mathematica Description Mathematica Description Mathematica <thdescrinter< th=""> Description Mathematica</thdescrinter<>
• Thus a shared data initialisation requirements is an operation on requirements documents.	Example 19.191 Shared Data Initialisation of Railway Net: We rough-sketch illustrate a case of shared data initialisation based on the
• It applies to a (projected and possibly determined, instantiated, extended and fitted) domain description, i.e., a domain requirements prescription,	rough sketch of Example 11.133 (Slide 1082).The software system shall start in an initial state
• and yields an interface requirements prescription,	\star which — rough-sketching — \star represents an empty rail net, and "ends" in a state which
 where the latter prescribes that certain information of the domain * is to be represented as a shared data structure in the machine, and 	 ★ includes a representation of an "entire" rail net, ★ i.e., a representation of all static and dynamic properties of each and every rail unit.
\star generally how such data is initially to be set up by the machine.	v
223, Far v 64 433 2014 © Dires Ryane, Fasheri, 1, 265 201 Mah, Senarak Senarak Senarah Adolesa aha, Senarah padaman Se, 1914. sena inan ahar A/ Se	- 16 623 278, Far + 16 683 827 💿 Dien Speer, Facherj 13, DE-309 Mith, Demait E-mail: delloradu di, speerdynal cari, denthjoer biz (16), sees inn die di
Volume 3 Volume 3 Department of Length Channels and Software Design Diff et EUK/DEERROR. Dumains, Requirements and Software Design Use and the software Design of the softw	OFTWARE EVOLUTEEBING: Domains, Requirements and Schware Design Volume 3 Operated Comparison of Departing 0.5.5 Shared Data Refreshment Table 2000 Shared Data Refreshments Without Schwards Without Schwards Michael United Schwards Schward Schwards (Schward Schward Schwa
\bullet In addition — as will be seen from other parts of these domain $/$ requirements 20 —	Shared Data Refreshment
 ★ it shall be possible to simply relate rail units to their physical surroundings: ♦ whether the rail runs along a platform, 	 Shared data, once initialised, usually need be kept updated. The domain — usually — changes, irrespective of any computing system inserted into it.
\diamond in a tunnel, up/down hill, is curved, etc.;	v
 ◇ the pertinent electric train power line segment; etc. ★ A special software subsystem shall handle the initial establishment of this start state as follows: 	
◇, etc.	
221, Far vill 1813 () Done Egner, Finder II, DO 288 Hale, Connex E. Fande definenzione, Sponedgeulane, development IV, 181, was invedued. "G	rtő 652 273, Far + el 483 1871 💿 Dies Tigens, Fadieg 11, 10-246 Mar, Banada & Fadiah dillemetha di Spareligiud Lan, diedlipera bis, UB, san Jan du A.
²⁰ This is not illustrated in these examples.	
E EXCINEEENGG Dawaine, Registrements and Schware Design Values 1 Grant and Schware Design Values 2 Grant and Schware Design Values 2 Grant and Schware Design Values 2 Grant Andréa Schware Values 2 Grant Andréa Schwar	OFTWARE ENGINEETING. Domains. Registrements and Software Design Videm 3 Proprint of compact factors of the compact factors
Characterisation 19.225 By shared data refreshment we understand a machine operation	• Thus a shared data refreshment requirements is an operation on requirements documents.
• which,	• It applies to an interface requirements prescription,
 * at prescribed intervals, * or in response to prescribed events, 	 where the latter prescribes that certain information of the domain * is to be represented as a shared data structure in the machine.
updates an (originally initialised) shared data structure $\hfill =$	• The shared data refreshment requirements then prescribe how often, and by which means, that shared data structure is to be refreshed (i.e., updated).
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hyvell/Jahl9/Gabl9	Items(id)(id)(i)(bit)(bit)(bit)(bit)) April 5.206, 1305 Page J2/6, Tagic 54, Fail: 30 Interfrace Requirements Computational Data and Control Interface Requirements ////////////////////////////////////
 requirements. Regular inspections of the wear and tear of the rail net units, signals, optical gates (and other sensors), road level crossings, etc., shall lead to similarly updating of that equipment's shared data structure, and such regular inspections shall be prompted by the machine and as prescribed 	 For many applications it is the case that the flow of computations that may be desired by the users, i.e., the stakeholders, shall be influenced by interaction between the machine and these users. That is: * It is often to be prescribed how such interaction shall take place,
by the required software.Inspections, with resulting updates, may take place before the usual expiry of inspection interval.And so on.	 ♦ whether by users interrupting the machine, ♦ or the machine polling the users, ★ and what it shall entail, i.e., which computational consequences the user
• Aid so di.	interference shall have.It is this, perhaps "grey-zone" facet that we call the computational data and control interface.
2), far e 6 60 801 🖉 an Egnes, Fraher II, DC 300 Nda, Danas Erash define da de Sport-Agnelian, dan Agree Na UR, seu inn da de/da	- viš 65 128, far viš 601 801 💿 Davi Bjene, Federaj 11, Dr. 300 Nate, Danast Federa Andre Andr
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Millionity/Abitity April 5. 2006, 13.08 Page 1270, Taple: 96, Fill 31 Resent/researched, Disable replayed, Sewart Characterisation 19.226 By computational data and control interface requirements which prescribe ////////////////////////////////////	Interview/op/unit/shalt/site April 5.2006.1305 Page 1278, Tepic 56, Fail: 32 Interview/Faile Tepic 56, Fail: 32 Example 19.193 Computational Data and Control Interface: / We continue Example 19.191. 19.191.
• that certain forms of input be provided over the user-machine interface,	• The railway net is represented, in the machine (database), by geographical area (i.e., area by area).
• in order to help control the flow of computation:	* Input of rail unit data is, in batches, by such areas.
 * when to start or stop certain subcomputations, and/or * with which argument data such subcomputations should be carried out, 	 Hence a computational data input specifies that "until further notice" the next many future unit inputs are intended to "belong" to that area.
★ etc	★ Another computational data input (i.e., the "further notice") specifies "the end" of such a series of area-specific unit data.
ENCRETENCE Duration. Requirements and Software Daright Values 3 Construct of Longent Construct of Longent Longent stational Data and Control Interface Requirements April 5.2006. 1365 Page 1726, Topic: 56, Feb 33 • Occassionally, during unit data input, that and past input may need	OFTWARE ENGINEERING. Domains, Respirements and Software Darige Volume 3 Equations of Concern Optioning, Water Standard International Software Standard Interna
be checked ("vetted"). * Hence a computational data input may specify that such vetting	Characterisation 19.227 By man-machine dialogue
 ★ and other, immediately subsequent computational data input 	requirements we understand the prescription of thesyntax (including sequential structure) and
may be prompted as to the specific nature of the desired checks. * Finally, prompts may inquire as to whether further checks need	semanticsof the communications (i.e., messages) transferred,
to be done, or the check series terminated.	 of the communications (i.e., messages) transferred, in either direction, over the interface between man and machine,
\star (We do not here specify the vetting procedures.) $\hfill\blacksquare$	 whether communicated textually through a keyboard (by the human) or on the screen (by machine), by a mouse or other tactile means (by human), or by voice (by human) or sound (by machine)
s fan - ef 193 304 🛞 Don Kjenn, Fashing II, Dr. Stêl Hilm, Danach Eanste diffusedine, de tjennefgentum, deneftjener bie Uit, waar sten die die "A"	- ef 405 172 for ef 468 851 🛞 Otor Egnes, Fashaj 11 05 305 Már, Davas E mah debaseh, ek hjerefynal on, derbljove ku (M. version ek
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It must be stressed that the man-machine dialogue referred to above subsumes the physiological interfaces mentioned next,	Example 19.194 Man-Machine Dialogue Requirements: We continue Example 19.192.
 but that it emphasises the sequencing of possibly alternative events and messages. 	 When, for any rail unit, its wear and tear information becomes older than six months,
 Thus man-machine dialogue is "overall" wrt. the individual man-machine physiological events and messages. 	 a message is to be displayed on the console (screen) of the railway net maintenance group responsible for that rail unit (this is an interface requirement).
	• This group must respond within 72 hours with the requested update information (this is a business process reengineering requirement).
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E-mails: de&mm.dta.dk, bjørner&gmail.com, denot8bjørner.biz; URL: www.imm.dt



Annotations:

+45 4525 3720, Fax: +45 4593 0074

5 3720. Fax: +45 4583 007

+45 4525 3720. Fax: +45 4580 0074

• Further on database references:

 \star an attribute name, **an**, and

★ in the name relation, rdb(rn),

* a selection criterion, sel,

* To de_reference a database reference

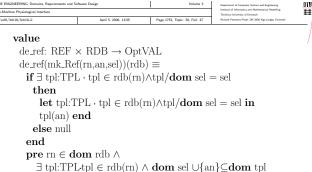
★ if not, then the null value is yielded.

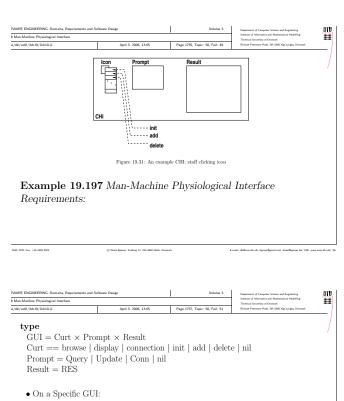
 \star is to inquire whether there exists a tuple, tpl,

 \star for which the selection criterion applies: tpl/dom sel = sel.

 \star If such a tuple is found, then it is the result of the dereferencing;

* consisting of a relation name, rn,





 $[\]star$ The graphical user interface, $gui{:}{\mathsf{GUI}},$ consists of three items:

♦ a scroll-down curtain, curt:Curt,

(2) Dines Bigmer, Fredozi 11, DK-2040

- o a prompt field, prompt:Prompt,
- \diamond and a result field, <code>result:Result</code>.
- \star A scroll-down curtain in the concrete lists exactly the available query and update commands possible on a timetable.
- \star These are designated by the keywords: browse, display, connection, init, add and delete.

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9.5.8 Man-Machine Physiological Interface		Department of Computer Science and Engineering Institute of Informatics and Mathematical Modelling
home/db/voll1/3ch19/3ch19-iii	April 5, 2006, 13:05	Technical University of Denmark Richard Petersens Plads, DK-2000 Kgs.Lyngby, Denma
highlighted. To one of these, we then the prompt for the prompt fo	Thus the above or, when none field, prompt:Pr e command, as	tain an appropriat ne curtain highligh

525 2720. Fax: +45 4593 007

Man-Machine Physiological Interface Internet Addating The Internet Addational Addationa Addational Addational Addationa	OFTWARE ENGINEERING: Domains, Requirements and Software Design Volume 3 Department of Computer Science and Engineering 9.5.8 Man-Matchine Physiological Interface 9.5.8 Man-Matchine Physiological In
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• In Example 19.183 we defined the semantics of query and update	value
• In Example 19.165 we defined the semantics of query and update /	
	client: $\mathrm{GUI} \to \mathrm{TT} \to \mathrm{GUI}$
\bullet We now use these definitions to define the requirements, namely	$\operatorname{client}(,,)(\operatorname{tt}) \equiv$
that these commands	let icon = browse \prod display \prod connection in
\star obtain their arguments, and, when subject to execution,	case icon of:
	browse \rightarrow (browse, mk_Brws(), $\mathcal{M}_q(\text{mk}_Brws())(\text{tt}))$,
\star deliver (deposit) their result into the user interface,	display
• that is, as part of the GUI.	\rightarrow let fn:Fn · fn \in dom tt \vee in
	$(display,mk_Disp(fn),\mathcal{M}_q(mk_Disp(fn))(tt))$ end,
	connection
	\rightarrow let ℓ :Nat,da,ta:An-{da,ta} \subseteq Ans(tt) $\land \dots$ in
	(connection,mk_Conn(ℓ ,da,ta), \mathcal{M}_q (mk_Conn(ℓ ,da,ta))(tt)) end
	end end
5 3220, Fac: +64 4601 0024 💿 Dione Egener, Frenkrey 11, DK-2040 Helte, Dennack E-maile: dedimentitus de, hjoren@genal.com, dione@ginese biz; UR: www.iem.dtr.dk/~db	+46 605 202, Fas: +46 688 00% () Eines Bjenner, Finden II, DK-380 Halte, Dennak E-mail: delfen das de, hjennefignal can, denebijene kir UR: www.iem.das
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an-Machine Physiological Interface Intervation Muthematical Mathematical Mathematic	9.5.8 Man-Machine Physiological Interface Internation Modeling Technical Modeling Technical Modeling
b/voll1/3ch10/3ch10/3ch10-iii April 5, 2006, 13:05 Page 1761, Topic: 56, Foil: 55 Richard Processes Plan, DK-300 HacLander, Devaul	homn/db/vdll/3ch19/3ch19/iii April 5, 2006, 13.05 Page 1762, Topic: 56, Foil: 56 Robel Present Plac, Dr. 200 Kpt. Ipub., Dennak
• Specific GUI: Timetable	\star If display then
	♦ it means that the curtain alternative display has been
A client, by his own decision, either issues a browse, or a display, or	
a connection query.	"clicked", and is hence highlighted,
\star If browse then	\diamond that a flight number is provided by the client, here shown as
\diamond it means that the curtain alternative browse has been	nondeterministically selected,
"clicked", and is hence highlighted,	\diamond that the prompt field shows the corresponding display
♦ that the prompt field shows an obvious mk_Brws() command,	command, mk_disp(fn),
	\diamond and the result field shows the result, $\mathcal{M}_q(mk_Disp(fn))(tt)$, of
requiring no arguments,	interpreting that command on the timetable.
\diamond and the result field shows the result, $\mathcal{M}_q(mk_Brws())(tt)$, of	morproving share command on the emicrapic.
interpreting that command on the timetable.	
1220, Fac: +6f-488 2024 © Diver Righten, Findung 11, DK-2040 Hilto, Donnak Evalue: definenditus di, ignore@granit.com, diverBigineni biz: UR: www.ine.dus.dl/db	-efe 663 020, Eur. +efe 668 001 © Diese Rijemer, Festivej 11, DK-Odel Hilto, Diesauk 🖉 - maik: differendasis, kjener@poal.com, dies@kjener.log.UK: www.inendasid
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* If connection then	value
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♦ it means that the curtain alternative display has been	staff: $\operatorname{GUI} \to \operatorname{TT} \to \operatorname{GUI} \times \operatorname{TT}$
"clicked", and is hence highlighted,	$staff(,,)(tt) \equiv$
\diamond that the maximum number of flight changes, ℓ , and departure	let icon = init $[]$ add $[]$ delete $[]$ in
da and destination ta airports are provided by the client, here	case icon of:
shown as nondeterministically selected,	init \rightarrow let (r,tt') = $\mathcal{M}_u(\text{mk_init}())(\text{tt})$ in ((init,tt',r),tt') end ,
\diamond that the prompt field shows the corresponding connection	add \rightarrow let fn:Fn,j:Journey \cdot fn $\not\in$ dom tt \vee in
command mk_Conn(ℓ ,da,ta),	let $(\mathbf{r}, \mathrm{tt'}) = \mathcal{M}_u(\mathrm{mk_add}(\mathrm{fn}, \mathrm{j}))(\mathrm{tt})$ in
	$((add,mk_add(fn,j),r),tt')$ end end,
	delete \rightarrow let fn:Fn \cdot fn \in dom tt \lor in
\diamond and the result field shows the result of interpreting that	
\diamond and the result held shows the result of interpreting that command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt)$.	
: 0	$let (r,tt) = \mathcal{M}_u(mk_del(fn))(tt) in$
. 0	$let (r,tt) = \mathcal{M}_u(mk_del(fn))(tt) in ((delete,mk_del(fn),r),tt) end end$
. 0	$let (r,tt) = \mathcal{M}_u(mk_del(fn))(tt) in$
. 0	$ \begin{aligned} \mathbf{let} & (\mathbf{r}, \mathbf{tt}) = \mathcal{M}_u(\mathbf{mk_del(fn)})(\mathbf{tt}) \mathbf{ in} \\ & ((\mathrm{delete, mk_del(fn), r}), \mathbf{tt}) \mathbf{ end end} \end{aligned} $
command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt).$	$ \begin{aligned} \mathbf{let} & (\mathbf{r}, \mathbf{tt}) = \mathcal{M}_u(\mathbf{mk_del(fn)})(\mathbf{tt}) \mathbf{ in} \\ & ((\mathrm{delete, mk_del(fn), r}), \mathbf{tt}) \mathbf{ end end} \end{aligned} $
command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt).$	$\label{eq:let_rtt} \begin{split} & \mathbf{let} \; (\mathbf{r}, \mathbf{tt}') = \mathcal{M}_u(\mathbf{mk.del}(\mathbf{fn}))(\mathbf{tt}) \; \mathbf{in} \\ & ((\mathrm{delete}, \mathrm{mk.del}(\mathbf{fn}), \mathbf{r}), \mathrm{tt}') \; \mathbf{end} \; \mathbf{end} \\ & \mathbf{end} \; \mathbf{end} \end{split}$
command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt).$	$\label{eq:let_rtt} \begin{split} & \mathbf{let} \; (\mathbf{r}, \mathrm{tt}') = \mathcal{M}_u(\mathrm{mk_del}(\mathrm{fn}))(\mathrm{tt}) \; \mathbf{in} \\ & ((\mathrm{delete}, \mathrm{mk_del}(\mathrm{fn}), \mathbf{r}), \mathrm{tt}') \; \mathbf{end} \; \mathbf{end} \\ & \mathbf{end} \; \mathbf{end} \end{split}$
command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt).$	$\label{eq:let_rtt} \begin{split} & \mathbf{let}~(\mathbf{r},\mathrm{tt}) = \mathcal{M}_u(\mathrm{mk_del}(\mathrm{fn}))(\mathrm{tt})~\mathbf{in}\\ & ((\mathrm{delete,mk_del}(\mathrm{fn}),\mathrm{r}),\mathrm{tt})~\mathbf{end}~\mathbf{end}\\ & \mathbf{end}~\mathbf{end} \end{split}$
command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt).$	$\begin{array}{c} \textbf{let} (r,tt') = \mathcal{M}_{\mathcal{U}}(mk_del(fn))(tt) \textbf{ in} \\ ((delete,mk_del(fn),r),tt') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$
EXECUTEDEDING Daradis, Reprintments and Schwarz Darige Valuer 3 EXECUTEDEDING Daradis, Reprintments and Schwarz Darige Valuer 3 Mathema Physicagnia Interfere Station 3	$\begin{array}{c} \textbf{let} (r,tt') = \mathcal{M}_{\mathcal{U}}(mk_del(fn))(tt) \textbf{ in} \\ ((delete,mk_del(fn),r),tt') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$
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Command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt).$ 20 No. 6000 No. Beginments and Schwarz Daige Value 3 Mathian Physizagial Interfere Name 3 Number No. 600 No. 6	let (r,tt') = $\mathcal{M}_u(mk.del(fn))(tt)$ in ((delete,mk.del(fn),r),tt') end end end end end end end end end end end extra end former, Regelements al Solver Deep Volum 1 Solver Reventerents Sol Markadash Physiological Insteine
RE ENCIREERING: Command from the timetable, $\mathcal{M}_q(mk_cConn(\ell,da,ta))(tt).$ NOR 76 + 6 000 NOV COM For + 6 000 NOV COM For + 6 000 NOV RE ENCIREERING: Comman, Registrements and Software Darger Machine Physicalization Interfaces Command Interfaces Command Interfaces Command Interfaces	Image: https://www.image: https://www.i
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Command on the timetable, $\mathcal{M}_q(mk_cConn(\ell,da,ta))(tt).$ 202.002.002.002.002.002.002.002.002.002	$\begin{array}{l} \textbf{let} (r,tt') = \mathcal{M}_{u}(mk.del(fn))(tt) \textbf{ in} \\ ((delete,mk.del(fn),r),tt') \textbf{ end end} \\ \textbf{end end} \end{array}$
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Command on the timetable, $\mathcal{M}_q(mk_cConn(\ell,da,ta))(tt).$ 202.002.002.002.002.002.002.002.002.002	$\begin{array}{l} \textbf{let} (r,tt') = \mathcal{M}_u(\textbf{mk.del}(fn))(tt) \textbf{ in} \\ ((delete,\textbf{mk.del}(fn),r),tt') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$
REENCHEENCE Command on the timetable, $\mathcal{M}_q(mk_cConn(\ell,da,ta))(tt).$ The result of the semantics functions illustrate the internal nondeterministic choices that the client, respectively the staff, makes — as seen from the point of view of the semantics — of the parameters that go into the specific query, respectively update commands.	$\begin{array}{l} \textbf{let} (r,tt') = \mathcal{M}_u(\textbf{mk.del}(fn))(tt) \textbf{ in} \\ ((delete,\textbf{mk.del}(fn),r),tt') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$
COMMAND on the timetable, $\mathcal{M}_q(mk_cConn(\ell,da,ta))(tt).$ TOTAL OF COMMAND ON THE SECOND OF COMMAND OF COM	$\begin{array}{c} \text{let}(\mathbf{r},\text{tt}') = \mathcal{M}_u(\text{mk}_\text{del}(\text{fn}))(\text{tt}) \text{ in }\\ ((\text{delete},\text{mk}_\text{del}(\text{fn}),\text{r}),\text{tt}') \text{ end end}\\ \text{end end}\\ \end{array}$
COMMAND On the timetable, $\mathcal{M}_q(mk_cConn(\ell,da,ta))(tt). COMMAND ON the timetable, \mathcal{M}_q(mk_cConn(\ell,da,ta))(tt). COMMAND ON the timetable, \mathcal{M}_q(mk_cConn(mk,mk))(tt). COMMAND ON the timetable, \mathcal{M}_q(mk,ta), \mathcal{M}_q(mk,ta), \mathcal{M}_q(mk,ta), \mathcal{M}_q(mk,ta), \mathcal{M}_q(mk,ta), \mathcal{M}_q(mk,ta))(mk,ta). COMMAND ON the timetable, \mathcal{M}_q(mk,ta), \mathcal{M}$	$\begin{array}{l} \left \text{let} (\mathbf{r}, \text{tt}') = \mathcal{M}_u(\text{mk}_d \text{eld}(fn))(\text{tt}) \text{ in } \\ ((\text{delete}, \text{mk}_d \text{eld}(fn), \mathbf{r}), \text{tt}') \text{ end end } \\ \text{end end} \\ \end{array}\right)^{(delete}, (delete, \text{mk}_d \text{eld}(fn), \mathbf{r}), \text{tt}') \text{ end end} \\ \\ \hline end end \\ \end{array}$
CONTRACT ON the timetable, $\mathcal{M}_q(mk_cConn(\ell,da,ta))(tt).$ CONTRACT ON the timetable, $\mathcal{M}_q(mk,conn(mk,conn(mk)))(tt).$ CONTRACT ON the timetable, $\mathcal{M}_q(mk,conn(mk,conn(mk)))(tt).$ CONTRACT ON the timetable, $\mathcal{M}_q(mk,conn(mk,conn(mk)))(mk))(mk).$ * For the display query it is the choice of the flight number. * For the connection query it is the choice of the maximum number of changes of flights, as well as the choice of the from (departure, or airport of	$\begin{array}{l} \textbf{et} (\textbf{r}, \textbf{tt}') = \mathcal{M}_u(\textbf{mk}_del(\textbf{fn})), (\textbf{tt}) \textbf{ in} \\ ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $\begin{array}{l} ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $\begin{array}{l} ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $\begin{array}{l} ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $\begin{array}{l} ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $\begin{array}{l} ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $\begin{array}{l} ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $\begin{array}{l} ((delete, \textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end end} \\ \textbf{end} \\ \textbf{end} \\ \end{array}$ $\begin{array}{l} (delete(\textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end} \\ \textbf{end} \\ \textbf{end} \\ \textbf{end} \\ \end{array}$ $\begin{array}{l} (delete(\textbf{mk}_del(\textbf{fn}), \textbf{r}), \textbf{tt}') \textbf{ end} \\ \textbf{end} \\$
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ecommand on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt). metadom in the timetable, \mathcal{M}_q(mk_Conn(\ell,da,ta))(tt). metadom in the timetable, \mathcal{M}_q(mk_conn] metadom in the tin $	$\begin{array}{l} \text{et} (\mathbf{r}, \mathrm{tt}') = \mathcal{M}_u(\mathrm{mk.del}(\mathrm{fn}))(\mathrm{tt}) \text{ in } \\ ((\mathrm{delete}, \mathrm{mk.del}(\mathrm{fn}), \mathrm{r}), \mathrm{tt}') \text{ end end} \\ \text{end end} \\ \end{array}$ $\begin{array}{c} \\ \hline \\ \\ \hline \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ $
example on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt). example of the timetable, \mathcal{M}_q(mk_Conn(\ell,da,ta))(tt). example of the timetable, the the timetable of timetable of $	$\begin{split} & et\ (r,tt') = \mathcal{M}_u(mk.del(fn))(tt)\ in \\ ((delete,mk.del(fn),r),tt')\ end\ end\\ end\ end\\ end end \end{split}$
Command on the timetable, $\mathcal{M}_q(mk_Conn(\ell,da,ta))(tt).$ EXERCISE	$\begin{array}{l} \textbf{et} (\textbf{r}, \textbf{tt}) = \mathcal{M}_u(\textbf{mk.del}(\textbf{fn})), (\textbf{tt}) \textbf{ in} \\ ((delete, \textbf{mk.del}(\textbf{fn}), \textbf{r}), \textbf{tt}) \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $(delete, \textbf{mk.del}(\textbf{fn}), \textbf{r}), \textbf{tt}) \textbf{ end end} \\ \textbf{end end} \\ \end{array}$ $(e^{1 \times 2 \times $
COMMAND On the timetable, $\mathcal{M}_q(mk_{C}Conn(\ell,da,ta))(tt).$ Command On the timetable, $\mathcal{M}_q(mk_{C}Conn(\ell,da,ta))(tt)(tt).$ Command On the timetable, $\mathcal{M}_q(mk,conn(ta))$ Command On the timetable, $\mathcal{M}_q(mk,conn(ta)))(tt)(te).$ Command On the timetable, $\mathcal{M}_q(mk,conn(ta)))(tt)(te))(te)$ C	$\begin{split} & \text{et}(\mathbf{r},\text{tt}') = \mathcal{M}_u(\text{mk}_\text{del}(\text{fn}))(\text{tt}) \text{ in } \\ & ((\text{delete},\text{mk}_\text{del}(\text{fn}),\text{r}),\text{tt}') \text{ end end} \\ & \text{end end} \\ \end{split}$ $((\text{delete},\text{mk}_\text{del}(\text{fn}),\text{r}),\text{tt}') \text{ end end} \\ & \text{end end} \\ \hline \\ \hline \\ (\text{end end} \\ \hline \\ $

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wahouti (Jabib/Jabib/ii) April 5, 2006, 13.06 Page 1297, Taple 56, Fail 42 Relative Present Plan, Di 2010 Fail-lear Down	Image (a) (vali) (bit) (bit) April 5, 2006, 13.05 Page 1788, Tape: 56, Fol. 61 Instant Format (bit) (bit) (bit) Characterisation 19.229 By machine-machine dialogue Instant (bit) Instant (bit)
Wachnie-Wachnie Dialogue	requirements we understand
• The desired machine is usually serving in a context in which it has	• syntax (incl. sequential structure) and
been fitted to other machines or to supporting technologies.	• semantics (i.e., meaning)
• These may provide sensory data or accept actuation (i.e., control) data.	• of the communications (i.e., messages) transferred
• Some fitted machines may provide for, or accept mass data	\bullet in either direction over the automated interface between machines
transfers.	(including supporting technologies)
• Usually supporting technologies provide for, or accept rather	
"small", i.e., single (simple) data transfers.	
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Example 19.198 Machine-Machine Dialogue Requirements:Rail switches are assumed, upon request, to provide sensory	• Only one of these buttons can be pressed in any one-minute interval.
signals, which report on their state: "straight" or "turn-off".And these rail switches will respond to control signals which,	• At half-minute intervals each switch reports its status, and that status shall be reflected in the cabin tower display.
• And these ran switches will respond to control signals which, within an assumed response time of their being issued, set the switch to a desired state ("straight" or "turn-off").	• When a "straight" or "turn-off" control button is depressed, then a signal shall be sent to the designated switch,
 The cabin tower maintains a display which shows the states of all switches in its associated station. 	• and that switch shall react accordingly within a 15-second time lapse.
Associated with this cabin tower display are two buttons: Pressing	• The cabin tower switch display shall sound and flash appropriate
either of these shall correspond to sending "straight" or "turn-off"	alarms if the switch status, within half a minute, is not the desired
control signals.	(control signalled) one.
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\bullet The above example admittedly provides only a very rough sketch	Example 19.199 Machine-Machine Dialogue Requirements:
indication.	• Suppose that an application calls for the massive transfer of data over noisy
• It also "links" up to (that is, strongly depends on related) machine	distances. • That is, the probability that transferred data may be corrupted, i.e., change
(including support technology) requirements, as covered next.	• That is, the probability that transience data may be consupred, i.e., change value during communication, is considerable.
	• What is known as a suitable data communication protocol therefore has to be prescribed, one that helps ensure detection of corrupted data so as to enable retransmission until it has been decided that a correct, i.e., uncorrupted, transfer
	has been completed.
	 These data communication protocols are of the kind that we would call machine-machine dialogues.
	• Other than treating this as a metaexample we shall not go into detail in this
	book.
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Discussion: Interface Requirements Dialogue Prescription Techniques and Tools	· /
	• We have outlined six reasonably distinguishable facets that the requirements engineer may need perform in order to construct an
• We have not, in this lecture on interface requirements, shown any gramples of or formalized the dialogue apparts of interface	interface requirements prescription.
examples of, or formalised the dialogue aspects of interface requirements.	• There may be other such facets.
• The term interface implies at least two interacting behaviours.	• The above six have been found useful in several development
The term interface implies at least two interfacing behaviours.Therefore techniques and tools (i.e., notations) for process	projects.
• Therefore techniques and tools (i.e., hotations) for process modelling are used in such formalisations.	• Knowing about them, their underlying principles, and their
• We refer to Vol. 1, Chap. 21 (Concurrent Specification	techniques and tools should help the requirements engineer to more
Programming) and Vol. 2, Chap. 13 (Message and Live	efficiently acquire interface requirements prescriptions, and to
Sequence Charts), where we cover formal tools and techniques for	document them, i.e., to structure their documentation logically.
modelling such interaction.	
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Special Principles and Techniques Interface requirements, in most people's minds and expression, are	Characterisation 19.230 By a user-friendly man-machine interface we understand one which somehow satisfies the following
concerned with so-called "user-friendliness".	criteria:
• That is, interface requirements focus, very much, on the form of the	• Faithful: The interface reflects only the shared phenomena and concepts, and reflects "absolutely" no machine (i.e., hardware +
dialogues and the layout of GUIs.Much can be said about this.	software) concepts (i.e., jargon). That is, the terminology used "across" the interface is that of the domain.
• We shall venture our definition of "user-friendliness".	• Didactic: The sequence of presentation of shared phenomena and
	concepts reflects some clarified view on how these phenomena and concepts relate, which are the more important ones, and which reflect current or changing business processes, support technologies, managements and organisations, rules and regulations, etc.
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April 5 2000, 13.05 Page 3777. Tagic 56, Feb 72 Manuar Fad. 50.300 Rainedy toward Pedagogic: The number of phenomena and concepts presented in	April 1, 2006, 1365 April 1, 2006, 1365 Pape 1727, Taple 56, Fail 73 Winder Wenner Wenk, 078 888 Reprinters Psychologic: Interaction response, incl. prompt times and texts
any one step of interaction is small, say from one to at most five.	should not irritate ²³ or shame the users, or make these users feel
The order of presentation is initially from core phenomena and concepts to increasingly derived phenomena and concepts. That	inadequate, or guilty (say, of "not knowing").
order may initially be pedantic, but is accepted by novice users.	• Artistic: And then it is certainly user-friendly, this author believes, if the interface reflects some artistic ideas.
For more experienced users means for clear, logical "shortcuts"	
should be made available.	The above characterisation is only approximate $\hfill \square$
• Physiologic: The number of current and alternative physiologic "gadgets" ²² needed to maintain interaction should be modest and be balanced against simplicity or complexity of interaction.	
5 п 6148 801 © Онг. Прил. Falley 11, 05 261826, Ропск Блай, Вулич Врайски, Вулич Врайски, Балавурич Во, 105, на слав, 6 / 26	- ef 453 726 For - ef 458 EVA
²⁹ Screen, keyboard, monse, other tactile instruments ("pointing to", pressure-sensitive screens), andio (i.e., loadspeakers), microphone, etc.	³⁹ The response to a user query, which took the user maybe a minute to prepare should not follow the submission of that query is the order of microseconds, rather 15–3 seconds is more pleasing, psychologically. For short, "disk" type "queries", response times of 100 milliceconds seem OK.
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If (340)(3418 iii April 5, 2006, 1345 Page 1270; Tepic 56, Fail 74 Record Product Product Records	السعر فقر بطال (2012)
student to pay strict attention to the issues we have raised:	Machine Requirements
\star Make sure that interface requirements, when referring to phenomena and concepts,	Characterisation 19.231 By machine requirements we
\star refer "strictly" to those that are well understood in the domain.	understand
	• those requirements that can be expressed
	\bullet solely in terms of (or with prime reference to) machine concepts
	· •
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e Regionemento Faceta M(26318)/263184v April 5, 2006, 13:05 Page 1781, Tegic: 57, Foll 2 Kinder Normer Tuto, 10:028 (April 4, page 1,	8.8.21 Requirements for "the Machine Ooly" Knot of Neural Internet Meetings Tackard Internet Meeting
Machine Requirements Facets	Machine Requirements and the Requirements Document
• We shall, in particular, consider the following five kinds of machine requirements:	• Some remarks need to be made
requirements:	• before we go into details of domain requirements modelling
* performance requirements,	techniques.
* dependability requirements, * maintenance requirements,	Requirements for "the Machine Only"
* maintenance requirements, * platform requirements and	• Machine requirements are about the machine only!
* documentation requirements.	\star They, the machine requirements, "in the extreme"
	\star contain no references to any specific aspect of the domain.
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n/db/vdll/3dx10/3dx10+iv April 5, 2006, 13.05 Page 1783, Topic: 57, Foil: 4 Roburt Presence Plak, DK-300 VgcLengh, Deesak	homs/db/vdll/3x319/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x300/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x3100/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x000/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x300/3x3000/3x300/3x300/3x000/
• But there may be general references, and they could be of the same /	• The machine requirements all take their "departure point",
nature for whichever domain was the base,	• that is, are based upon,
• such as,	• potentially available machine technology,
\star such and such function invocations shall terminate in less than	• whether
m microseconds,	\star central. or
\star whereas such and such function invocations shall terminate in less than n seconds.	\star distributed, or
	\star input/output, or
• Or,	\star peripheral.
\star such and such data shall be replicated for back-up reasons, \star or auxiliary storage for performing such and such functions shall	
be less than 500 KB.	
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WARE ENCLIFEERING: Domains, Requirements and Software Design Unline 4 Contract of Contract, Unline 4 Contract of U	OFTWARE ENG/Density, Despiratents and Software Design Volume 3 Department of Copies of
2 Place in Narrative and Formalisation Document Televisi Unional on Microsoft Manual of Manual And	6.5.2.2 Place in Narration and Fermulaution Document Institution (1998) Institution (1998
Place in Narrative and Formalisation Document	• The machine requirements are really void of any (material) reference
• Later in this lecture we shall treat a number of machine	• to domain phenomena and concepts.
requirements facets.	
\star Each of whichever you decide to focus on,	Hence the machine requirements prescriptions form a compared "financial disc" document
\star in any one requirements development,	• form a separate, "freestanding" document.
\star must be prescribed.	• That document must describe both the machine component
	\star (i.e., hardware,
	\star and software)
	\bullet interfaces and functionalities
	• (the latter, say, in pre/postcondition form).
ARE EPIGNEERING. Domains, Requirements and Software Design Volume 3 Department Compare a Compare Software Original Software Compares Software Original Software Compares Software Original Softw	OFTWARE ENGINEERING. Duraine, Requirements and Software Design Volume 3 Departure of Corpora Genera sol Egisonica 64.3 Performants Requirements
formance Requirements	6.8.3 Performants Requirements Table 2000 and 20
Performance Requirements	• Pragmatically speaking, performance requirements translate into
Characterisation 19.232 By performance requirements we mean machine requirements that	financial resources spent, or to be spent.
prescribe	Example 19.200 Performance Requirements: We continue
• storage consumption,	Example 19.185.
• (execution, access, etc.) time consumption,	• The machine shall serve 1000 users and 1 staff member.
 as well as consumption of any other machine resource: 	• Average response time shall be at most 1.5 seconds,
* number of CPU units (incl. their quantitative characteristics such as cost, etc.),	• when the system is fully utilised.
★ number of printers, displays, etc., terminals (incl. their quantitative characteristics), ★ number of "other", ancillary software packages (incl. their quantitative characteristics),	- when the system is rang atmode.
\star of data communication bandwidth,	•
\star etcetera	
. ■ .	
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Genarace Requirements Testica of Manufact Multility ####################################	0.6.3 Pederanaca Requirements Intel Views April 5, 2006, 11.05 Page 1790, Topic 57, Fol: 11 Rical Hows (Beylaph Denak
• Till now we may have expressed certain (functions and) behaviours as generic (functions and) behaviours.	Example 19.201 <i>Performance Requirements:</i> We continue Example 19.183 and Example 19.200.
• From now on we may have to "split" a specified behaviour	• In Example 19.183 the sharing of the timetable between users and
 ★ into an indexed family of behaviours, ★ all "near identical" save for the unique index. 	staff was expressed parametrically. $system(tt) \equiv client(tt) \mid staff(tt)$
• And we may have to separate out, as a special behaviour, (those	
of) shared entities.	client: TT \rightarrow Unit client(tt) \equiv let q:Query in let $v = \mathcal{M}_q(q)(tt)$ in system(tt) end end
	staff: $TT \rightarrow Unit$
	staff(tt) \equiv let u:Update in let (r,tt') = $\mathcal{M}_u(u)(tt)$ in system(tt') end end
	u = u = prante in ret (1, ut) = mu(u)(ut) in system(ut) end end
5 3220, Fac: +46 6683 0074 © Dinne Bjørner, Fredonj 11, DN 2869 Helte, Dennark E-maile: dellimmettande, bjørner@ganal.com, dinnetBjørne biz; URL: www.immetta.dk/:db	146 KEZ 1226, Fac. v K KEH KEY 🔅 Ditan Kgener, Fackoj Li, Do 2406 Main, Genauk 🖉 Fende Addersature, A. Spener Appeal an, Amerikana Advi USI. senaitem Advid J

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Vall (Job19) Job19 / J	kems/db/vdll/3k38/3k39-5ir April 5, 2006, 13:05 Page 1392, Topic 57, Feil: 13 Rotar Provence Pade, DK-380 Fe, Lingle, Denask
• We now factor the timetable entity out as a separate behaviour,	type //
• accessible, via indexed communications, i.e., channels,	CIdx /* Index set of, say 1000 terminals */ channel
• by a family of client behaviours and the staff behaviour.	{ ct[i]:QU,tc[i]:VAL i:CIdx }
	st:UP,ts:RES
	value
	system: $TT \rightarrow Unit$ system(tt) \equiv time_table(tt) ({client(i) i:CIdx}) staff()
	$System(v) = vinc_val(v) \parallel (\parallel (vicin(i) vicin(j)) \parallel val(j))$
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II/3ch19/3ch19-irv April 5, 2006, 13:05 Page 1703, Topic: 57, Foil: 14 Richard Pennese Foak, DK-3000 Kpit.jurgh, Doward	home/db/vall/2ch10
client: i:CIdx \rightarrow out ct[i] in tc[i] Unit	• Please observe the "shift"
client(i) \equiv let qc:Query in ct[i]: $\mathcal{M}_q(qc)$ end tc[i]?;client(i)	\star from using [] in $system$ earlier in this example
() ····· ··· · ···· ···················	* to [] just above.
staff: Unit \rightarrow out st in ts Unit	• The former expresses nondeterministic internal choice.
$\operatorname{staff}() \equiv \operatorname{let} \operatorname{uc:Update} \operatorname{in} \operatorname{st}\mathcal{M}_u(\operatorname{uc}) \operatorname{end} \operatorname{let} \operatorname{res} = \operatorname{ts}? \operatorname{in} \operatorname{staff}() \operatorname{end}$	*
	• The latter expresses nondeterministic external choice.
time_table: $TT \rightarrow in \{ct[i] i:CIdx\}, st out \{tc[i] i:CIdx\}, ts Unit$	• The change can be justified as follows:
time_table(tt) \equiv	* The former, the nondeterministic internal choice, was "between" two
$[] {let qf = ct[i]? in tc[i]!qf(tt) end i:CIdx}$	expressions which express no external possibility of influencing the choice.
[] let uf = st? in let $(tt',r)=uf(tt)$ in ts!r; time_table(tt') end end	★ The latter, the nondeterministic external choice, is "between" two expressions where both express the possibility of an external input, i.e., a choice.
	• The latter is thus acceptable as an implementation of the former.
	•
, Sac + 66 601 8014 © Direct Episore Frederic 11, Dir 2016 Hills, Damast Ersals: delfenendisch, lejerer@grad.com, daveRijserer biz UR: www.izer.et.et.d/ de	-16 605 202, Sz16 481 001 💿 Dass Bjøns, Fallon II., DK-346 Hits, Danuk Ernik, dellann da. 6. lýsondpul car, darðhýnar bir, UK. 1990-inn da. 6
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• The next example, Example 19.202, continues the performance	Example 19.202 Performance Requirements: We continue
requirements expressed just above.	Example 19.185.
• Those two requirements could have been put in one phrase, i.e., as	• When performing the <i>n</i> -Transfer Travel Inquiry (rough sketch)
one prescription unit.	• When performing the <i>n</i> -maister maker inquiry (rough sketch) prescribed above,
	. ,
• But we prefer to separate them, as they pertain to different kinds	\star the first — of an expected many — result shall be communicated
(types, categories) of resources: terminal + data communication	back to the inquirer in less than 5 seconds after the inquiry has
equipment facilities versus time and space.	been submitted,
	\star and, at no time during the calculation of the "next" results must
	the storage buffer needed to calculate these exceed around
	100,000 bytes.
	•
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Dependability Requirements	Characterisation 19.233 • A machine failure occurs
2 openausmey reequirements	· · · · · · · · · · · · · · · · · · ·
• To properly define the concept of <i>dependability</i> we need first	• when the delivered service
introduce and define the concepts of	• deviates from fulfilling the machine function,
* failure,	\bullet the latter being what the machine is aimed at
	· · · · · · · · · · · · · · · · · · ·
* error, and	
\star fault.	
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- is an indication that a failure occurs or has occurred - The term locate is here taken to recent these reaching the sense as the term faile Considerational read the primes, "radjudged or hypothesised cause" - and the cause which is international read the primes, "radjudged or hypothesised cause" - and the cause which is international read the primes, "radjudged or hypothesised cause" - and the cause which is international read the primes, "radjudged or hypothesised cause" - and the cause which is international read to be presented or - formation in the cause matching there hadrond the table read a site is backnice - a site is propertied a machine or a (nobler) system - which is discussed a site is propertied a machine or a factorer set is backnice - a site is propertied a machine read the read the read a site is propertied a machine read the read				
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 e. where a user is a human, another machine or a(nother) system e. which intersects with it e. and intersects with it e			\bullet such that reliance can justifiably be placed on the service it delivers	
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 Having already discussed the "threads" aspect, We shall therefore discuss the "means" aspect of the dependability tree. Attributes: Accossibility Accossibility<!--</td--><td>Nependability Requirements Institute of Informatics and Mathematical Modeling Tachnical Wolwealy of Descards</td><td></td><td>0.6.4 Dependability Requirements Industry of Downak</td><td></td>	Nependability Requirements Institute of Informatics and Mathematical Modeling Tachnical Wolwealy of Descards		0.6.4 Dependability Requirements Industry of Downak	
 • we shall therefore discuss the "means" aspect of the dependability tree. • Attributes: • Accessibility: • Availability: • Integrity: • Safety: • Security: * Procurement: • Fault forecasting: • Characterisation 19.238 By a dependability attribute we shall mean either one of the following: • accessibility; • accessibility; • accessibility; • accessibility; • accessibility; • accessibility; • reliability; • reliabilit		-/		_
 Attributes: Accessibility Accessibility<!--</td--><td></td><td>/</td><td></td><td>/</td>		/		/
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 * Faults * Errors * Errors * Faults * Errors * Faults * Errors * Faults * Errors * Faults * Errors * E	*		• Threats:	
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prevention,mean either one of the following:• faults are created.• accessibility,• Hence the need for fault removal.• availability,• Fault removal is itself imperfect.• integrity,• Hence the need for fault forecasting.• reliability,• Our increasing dependence on computing systems in the end brings in the need for fault tolerance.• robustness,• safety and• safety and	Dependability Requirements Technical Modeling Technical University of Desmark		9.5.4 Expendability requirements Techical University of Desmark	Ħ
 faults are created. faults are created. Hence the need for fault removal. Fault removal is itself imperfect. Hence the need for fault forecasting. Our increasing dependence on computing systems in the end brings in the need for fault tolerance. Our increasing dependence. accessibility, availability, integrity, reliability, robustness, safety and 		/	· - ·	/
 Hence the need for fault removal. Fault removal is itself imperfect. Hence the need for fault forecasting. Our increasing dependence on computing systems in the end brings in the need for fault tolerance. availability, integrity, reliability, robustness, safety and 			~	
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That is, a machine is dependable if it satisfies some degree of "mixture" of being	Accessibility
 accessible, available, having integrity, and being reliable, safe and secure. The crucial term above is "satisfies". 	• Usually a desired, i.e., the required, computing system, i.e., the machine, will be used by many users — over "near-identical" time
• The issue is: To what "degree"?	intervals.
 As we shall see — in a later later lecture — to cope properly * with dependability requirements and 	• Their being granted access to computing time is usually specified, at an abstract level, as being determined by some internal nondeterministic choice, that is: essentially by "tossing a coin"!
\star their resolution	
requires that we deploy	• If such internal nondeterminism was carried over, into an implementation, some "coin tossers" might never get access to the
\star mathematical formulation techniques,	machine.
\star including analysis and simulation,	
from statistics (stochastics, etc.).	
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Characterisation 19.239 A system being accessible — in the / context of a machine being dependable —	Example 19.203 Accessibility Requirements: Timetable Access: /
• means that some form of "fairness"	• The timetable (system) shall be inquirable by any number of users,
• is achieved in guaranteeing users "equal" access	 and shall be updateable by a few, so authorised, airline staff. At any time it is generated that up towards a they are are
 to machine resources, notably computing time (and what derives from that) 	• At any time it is expected that up towards a thousand users are directing queries at the timetable (system).
· · · · · · · · · · · · · · · · · · ·	• And at regular times, say at midnights between Saturdays and Sundays, airline staff are making updates to the timetable (system).
	• No matter how many users are "on line" with the timetable (system), each user shall be given the appearance that that user has exclusive access to the timetable (system).
	has exclusive access to the timetable (system).
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Availability	Characterisation 19.240 By availability — in the context of a
• Usually a desired, i.e., the required, computing system, i.e., the	machine being dependable — we mean
machine, will be used by many users — over "near-identical" time	• its readiness for usage.
intervals.	• That is, that some form of "guaranteed percentage of computing
• Once a user has been granted access to machine resources, usually	time" per time interval (or percentage of some other computing
computing time, that user's computation may effectively make the	resource consumption)
	resource consumption)is achieved — hence some form of "time slicing" is to be effected
computing time, that user's computation may effectively make the	. /
computing time, that user's computation may effectively make the machine unavailable to other users —	. /
computing time, that user's computation may effectively make the machine unavailable to other users —	. /
computing time, that user's computation may effectively make the machine unavailable to other users —	. /
computing time, that user's computation may effectively make the machine unavailable to other users — by "going on and on and on"! 	
computing time, that user's computation may effectively make the machine unavailable to other users — by "going on and on and on"! 	• is achieved — hence some form of <i>"time slicing</i> " is to be effected
computing time, that user's computation may effectively make the machine unavailable to other users — 6 by "going on and on and on"! 6 by "going on and on"	• is achieved — hence some form of <i>"time slicing</i> " is to be effected
computing time, that user's computation may effectively make the machine unavailable to other users — • by "going on and on and on"! • by "going on and on and on"! • extracted to the second of the second	• is achieved — hence some form of <i>"time slicing</i> " is to be effected • of 60 EDL for (4 60 EDM • of 60 EDM
computing time, that user's computation may effectively make the machine unavailable to other users — 6 by "going on and on and on"! 6 by "going on and on and on "! 6 by "going on and on and on	• is achieved — hence some form of <i>"time slicing</i> " is to be effected
computing time, that user's computation may effectively make the machine unavailable to other users — by "going on and on and on"! ⁽²⁰²²⁾ ⁽²⁰²⁾	• is achieved — hence some form of <i>"time slicing</i> " is to be effected
computing time, that user's computation may effectively make the machine unavailable to other users — by "going on and on and on"! WREERCREEPTIC Descine Regiments of Software Design (MARKED Descine Regiments at Software Design) (MARKED Descine Regiments at Software Descine) (MARKED Descine Regiments at Software Regiment at Software Regiments at Software Regi	• is achieved — hence some form of <i>"time slicing</i> " is to be effected
computing time, that user's computation may effectively make the machine unavailable to other users — by "going on and on and on"! we were not and on and on "! we were not any the second of the se	• is achieved — hence some form of <i>"time slicing</i> " is to be effected
computing time, that user's computation may effectively make the machine unavailable to other users — • by "going on and on and on"! • by "going on and on an	 is achieved — hence some form of <i>"time slicing</i>" is to be effected Interview (Mark 1998) Interview (Mark 1998)
computing time, that user's computation may effectively make the machine unavailable to other users — • by "going on and on and on"! • by "going on and on and on"! EXERTING COMMUNICATION OF COMPUTATION OF C	 • is achieved — hence some form of <i>"time slicing</i>" is to be effected • is achieved — hence some form of <i>"time slicing</i>" is to be effected
computing time, that user's computation may effectively make the machine unavailable to other users — • by "going on and on and on"! • by "going on and on and on "going on and on and on the poss	 is achieved — hence some form of <i>"time slicing</i>" is to be effected Interview (Mark 1998) Interview (Mark 1998)

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Reliability	Safety
Characterisation 19.242 A system being reliable — in the	Characterisation 19.243 By safety — in the context of a machine
context of a machine being dependable — means	being dependable — we mean
• some measure of continuous correct service,	• some measure of continuous delivery of service of
• that is, measure of time to failure	\star either correct service, or incorrect service after benign failure,
	• that is: Measure of time to catastrophic failure
Example 19.205 Timetable Reliability:	
• Mean time between failures shall be at least 30 days,	Example 19.206 Timetable Safety:
• and downtime due to failure (i.e., an availability requirements)	• Mean time between failures
shall, for 90% of such cases, be less than 2 hours.	• whose resulting downtime is more than 4 hours
•	• shall be at least 120 days.
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DKUNEERING Domain, Requirements and Software Design Volum 3 Opportune of Cospon Science and Cogario infy The Software	0/TYWARE ENCAREERING: Domains, Requirements and Software Dosign 8.6.4.6 Security being shylloglably in the security of the
Security /	Characterisation 19.244 A system being <i>secure</i> — in the context / of a machine being dependable —
• Security requires a notion of <i>authorised user</i> ,	• means that an <i>unauthorised user</i> , after believing that he or she
with authorised users being fine-grained authorised to access only a	has had access to a requested system resource:
well-defined subset of system resources (data, functions, etc.).	\star cannot find out what the system resource is doing,
• An unauthorised user (for a resource) is anyone who is not	\star cannot find out how the system resource is working
authorised access to that resource.	\star and does not know that he/she does not know!
	\bullet That is, prevention of unauthorised access to computing and/or
	handling of information (i.e., data)
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names. Level and an analysis of the second s	or vrivnic continue continue continue or generative origin continue origine continue origin
• The characterisation of security is rather abstract.	Example 19.207 Security Requirements: Timetable Security:
• As such it is really no good as an a priori design guide.	We continue Examples 19.183, 19.185, 19.203, and 19.204.
• That is, the characterisation gives no hints as how to implement a	• Timetable users can be any airline client logging in as a user, and
• That is, the characterisation gives no mints as now to implement a secure system.	such (logged-in) users may inquire the timetable.
• But, once a system is implemented, and claimed secure, the	• The timetable machine shall be secure against timetable updates
characterisation is useful as a guide on how to test for security!	from any user.
	 Airline staff shall be authorised to both update and inquire, in a same session.
	баше беббіон.
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Example 19.208 Security Requirements: A Hospital	Robustness
nformation System:	Characterisation 19.245 A system is <i>robust</i> — in the context of
• General access to (including copying rights of) patient's medical	dependability —
journals is granted only to designated hospital staff.	• if it retains its attributes
• In certain forms of emergency situations any hospital staff may , get access to a hospital patient's medical journal.	\star after failure, and
	\star after maintenance
• Such incidents shall be duly and properly recorded and reported	
• Such incidents shall be duly and properly recorded and reported.	· · · · · · · · · · · · · · · · · · ·
• Such incidents shall be duly and properly recorded and reported.	• Thus a robust system is "stable"
• Such incidents shall be duly and properly recorded and reported.	• Thus a robust system is "stable"
• Such incidents shall be duly and properly recorded and reported.	\star across failures
• Such incidents shall be duly and properly recorded and reported.	•

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Timetable System: • The timetable system is expected to be implemented in terms of a number of components that implement respective domain and interface requirements, as well as some (other) machine requirements. • Characterisation 19.248 By corrective maintenance we understand such maintenance which • The overall timetable system shall have these components connected, i.e., interfaced with one another — where they need to be interfaced — in such a way that any component can later be replaced by another component stant any component can later be replaced by another component ostensibly delivering the same service, i.e., functionalities and behaviour. • Corrective maintenance shall be done remotely: • from a developer site, • from a developer site, • via secure Internet connections. • via secure Internet connections. • Corrective Maintenance • Went • Corrective maintenance weintenance • Went • Metabolize • Went	Ħ	9.6.5.2 Corrective Maintenance Technical University of Dennak	Institute of Informatics and Mathematical Modelling Technical University of Denmark	
Timetable System: • The timetable system is expected to be implemented in terms of a number of components that implement respective domain and interface requirements, as well as some (other) machine requirements. • Characterisation 19.248 By corrective maintenance we understand such maintenance which • The overall timetable system shall have these components connected, i.e., interfaced with one another — where they need to be interfaced — in such a way that any component can later be replaced by another component stant any component can later be replaced by another component ostensibly delivering the same service, i.e., functionalities and behaviour. • Corrective maintenance shall be done remotely: • from a developer site, • from a developer site, • via secure Internet connections. • via secure Internet connections. • Corrective Maintenance • Went • Corrective maintenance weintenance • Went • Metabolize • Went	_/	Corrective Maintenance	rements:	Example 19.209 Adaptive Maintenance Requ
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 number of components that implement respective domain and interface requirements, as well as some (other) machine requirements. The overall timetable system shall have these components connected, i.e., interfaced with one another — where they need to be interfaced — in such a way that any component can later be replaced by another component ostensibly delivering the same service, i.e., functionalities and behaviour. Example 19.210 <i>Corrective Maintenance Requirements:</i> Corrective maintenance shall be done remotely: * from a developer site, * via secure Internet connections. Output tensor Output tenso		*	nted in terms of a	• The timetable system is expected to be implem
 The overall timetable system shall have these components connected, i.e., interfaced with one another — where they need to be interfaced — in such a way that any component can later be replaced by another component stensibly delivering the same service, i.e., functionalities and behaviour. Example 19.210 Corrective Maintenance Requirements: Corrective maintenance shall be done remotely: from a developer site, via secure Internet connections. OUNT OFFICIVE Maintenance Outcome Maintenance Outcome Maintenance Outcome Maintenance Characterisation 19.249 By perfective maintenance we understand such maintenance which helps improve (i.e., lower) the need for helps improve (i.e., lower) the need for helps improve (i.e., lower) the need for helps improve (i.e., lower), the need for helps improve (i.e., lower) the need for <p< td=""><td></td><td></td><td></td><td>1 1 1</td></p<>				1 1 1
• The overall timetable system shall have these components connected, i.e., interfaced with one another — where they need to be interfaced — in such a way that any component can later be replaced by another component ostensibly delivering the same service, i.e., functionalities and behaviour. • • • • • • • • • • • • • • • • • • •	_		lachine	
 connected, i.e., interfaced with one another — where they need to be interfaced — in such a way that any component can later be replaced by another component ostensibly delivering the same service, i.e., functionalities and behaviour. A contracterisation 19.249 By perfective maintenance we understand such maintenance which helps improve (i.e., lower) the need for hardware (storage, time, equipment), 	-	· Francische 10.010 Commuties Maintanana Daminum atte	ma on onto	*
 be interfaced — in such a way that any component can later be replaced by another component ostensibly delivering the same service, i.e., functionalities and behaviour. Another component ostensibly delivering the same service, i.e., functionalities and behaviour. Another component ostensibly delivering the same service, i.e., functionalities and behaviour. Another component ostensibly delivering the same service, i.e., functionalities and behaviour. Another component ostensibly delivering the same service, i.e., functionalities and behaviour. Another component ostensibly delivering the same service, i.e., functionalities and behaviour. Another component ostensibly delivering the same service, i.e., functionalities and behaviour. Another component ostensibly delivering the same service, i.e., forestall, future occurrence Another component ostensibly delivering the same service, i.e., forestall, future occurrence Another component ostensibly delivering the same service (storage, time, equipment), 			-	*
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NEXE 24.0 2.000 V. (2000000 V.M. (100000 V.M. (10000 V.M. (1		\star via secure Internet connections.		service, i.e., functionalities and behaviour.
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Perfective Maintenance Characterisation 19.249 By perfective maintenance we understand such maintenance which • helps improve (i.e., lower) the need for • hardware (storage, time, equipment),	Ħ	0.6.5.4 Preventive Maintenance Interview of Company of	Institute of Informatics and Mathematical Modelling Technical University of Denmark	5.3 Perfective Maintenance
Characterisation 19.249 By perfective maintenance we understand such maintenance which helps improve (i.e., lower) the need for hardware (storage, time, equipment), Characterisation 19.250 By preventive maintenance we understand such maintenance which helps detect, i.e., forestall, future occurrence of software or hardware errors 	-/			
maintenance which understand such maintenance which • helps improve (i.e., lower) the need for • helps detect, i.e., forestall, future occurrence • hardware (storage, time, equipment), • of software or hardware errors	/		1	
 helps improve (i.e., lower) the need for hardware (storage, time, equipment), of software or hardware errors 		v 1	understand such	
hardware (storage, time, equipment), for the storage of t				
• of software or hardware errors				
• as well as software		• of software or hardware errors		• as well as software
	•		•	
Example 19.211 Perfective Maintenance Requirements: Timetable System:			Timetable System:	Example 19.211 Perfective Maintenance Requirement
• The system shall be designed in such a way as to				\bullet The system shall be designed in such a way as to
\star clearly be able to monitor the use of				
* "scratch" (i.e., buffer) storage and compute time				
for any instance of any query command.				tor any instance of any query command.
455 120, Far + 6 481 801 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	vervieren dtu dk/*du	+66 655 2020, Fax +66 668 80% © Dime Byrne, Fasting 11, 04:346 Mein, Damask E-milt definenda di, hjenerðynal son, dombjære kit URL voru	debinnetu de, hjorentgenal con, dinetbijener biz UR: www.innetu.du.du/"da	455 3726, Fac: +6: 4683 5074 (2) Disks [genes, Finites] 11, DM-2868 Helte, Dennach

E BLGINEERING: Domains, Requirements and Software Design Utility emioral Maintenance Training Utility (Comparison of the Software Design	OFTWARE ENGINEERING: Domain, Requirements and Software Dasign Volume 3 Department of Computer Solice and Engineering 9.6.5.5 Extensional Maintenance Technical Maintenance
081/3dx10/3dx10-kir 081/3dx10/3dx10-kir Robert Page 1833, Topic 57, Fab: 52 Robert Province Paul, 95:000 Npc1/aph, Decent	homs/db/vdll/2b39-bir April 5, 3006, 13:05 Page 1822, Topic 57, Foll 53 Robot Present Pade, 04:388 Vg.Lapola, Donard
Extensional Maintenance	• If a subsequent release of that software
Characterisation 19.251 By extensional maintenance we	\star is now expected to also calculate fastest routes
understand such maintenance which adds new functionalities to the software, i.e., which implements additional requirements.	★ in response to a travel query,
Example 19.212 Extensional Maintenance Requirements:	 then we say that the implementation of that last requirements constitutes extensional maintenance.
Timetable System:	
• Assume a release of a timetable software system to implement a requirements that, for example, expresses	
\star that shortest routes	
\star but not that fastest routes be found	
\star in response to a travel query.	
l for + 6 69 30% © Direc Falsey (1, 150 200 Mats, Dennat Erails definedus, Symonographics, Samolyper Liu, US, was into dis A (* A	viš 45.1 29. Jur - 46.6 10.1014 💿 Dime Tageren, Faskoj (1, 155.200 Hole, Samust Escult definendus), kjenerligund par davellijovesku (10, samust
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Agel 5, 2005, 11.05 Page 1833, Tapic 37, Fail: 54 Robert Persons Plats, CO308 Relation bounds	ham, (d), (d), (d), (d), (d), (d), (d), (d)
• Whenever a maintenance job has been concluded, the software	
system is to undergo an extensive acceptance test:	Characterisation 19.252 By a [computing] <i>platform</i> is here understood a combination of hardware and systems software — so
• a predetermined, large set of (typically thousands of) test programs has to be successfully executed.	equipped as to be able to execute the software being requirements prescribed — and 'more'.
	Characterisation 19.253 By platform requirements we mean a
	combination of the following:
	• development platform requirements,
	• execution platform requirements,
	\bullet maintenance platform requirements and
	• demonstration platform requirements
ر دول ۲۰۰۵ کې ۲۰۰۵ کې ۲۰۰۵ کې ۲۰۰۵ کې	-r6 65 202 For -r6 661 801 💿 Dan Bjønn, Falskij 11,05 360 Hills, Danask E-nais, deðina da A, kjannfynd Lan, dæðinanska K, kjannfynd Lan, dæðinanska
NCNEEERNG: Counsin, Registrements and Software Darige Volum 3 + Registrements ///AB31/AB36-ir //April 5. 2006, 11.55 Page 1EST. Topic: 57. Fol: 5 Cxaample 19.213 Platform Requirements: Space Satellite	OFTWARE ENGINEERING, Damains, Requirements and Software Danja. Volume 3 8.6.1 Development Platform Index (Main State Present Plate Constraint) (Main State P
Software: Elsewhere prescribed software for some space satellite	
unction is to satisfy the following platform requirements:	Characterisation 19.254 Development Platform Requirements: By development platform requirements we shall understand such
• shall be developed on a Sun workstation under Sun UNIX,	By development platform requirements we shall understand such machine requirements which
\bullet shall execute on the military MI1750 hardware computer running	• detail the specific software and hardware
its proprietary MI1750 Operating System,	
• shall be maintained at the NASA Houston, TX installation of	for the platform on which the softwareis to be developed
MI1750 Emulating Sun Sparc Stations, andshall be demonstrated on ordinary Sun workstations under Sun	
UNIX.	
Far + 6 60 10 N C Dave Egnes, Federa (1, 56 30 6 Hab, Davask Enable & Enable & Mennethy & Jone Myrrad Lon, daveByrrad Lon, daveByr	+46 453 123, Far +46 463 151 () Son Sport, Fachoq 11, DK 304 Hoto, Danask E-nait: Adhan da, SportAparlane, dankhjane ski, UK: san kor
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Takini Johniy / Dowak Agel 5, 2006, 11:05 Page 1837, Tapic 57, Fail: 58 Robert Present Page 100 Page 1	Norm April 5, 2006, 13:05 Page 1338, Topic: 57, Foil: 59 Exclusion of Councel Norm April 5, 2006, 13:05 Page 1338, Topic: 57, Foil: 59 Exclusion from Page 10:02:00 Figure (Denoted
Execution Platform	Maintenance Platform
Characterisation 19.255 Execution Platform Requirements:	Characterisation 19.256 Maintenance Platform Requirements:
By execution platform requirements we shall understand such	By maintenance platform requirements we shall understand such
nachine requirements which	machine requirements which
\bullet detail the specific (other) software and hardware	\bullet detail the specific (other) software and hardware
	\bullet for the platform on which the software
• for the platform on which the software	• is to be maintained
-	• IS to be maintained
 for the platform on which the software is to be executed	
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Voll/2010/30439-iv April 5, 2006, 11.05 Page 1339, Topic: 57, Fail: 60 Robust Process Paul, 05:200 Kp.Laplp, Denaul	home/db/vdll/3d3l/3d3l-iv April 5, 2006, 11.05 Progr.1840, Tapic: 57, Fail: 41 Ristor Present Pair, 06:380 Fail-pair, Desent
Demonstration Platform	Discussion
Characterisation 19.257 Demonstration Platform	• Example 19.213 is rather superficial.
Requirements: By demonstration platform requirements we shall understand such machine requirements which	• And we do not give examples for each of the specific four platforms.
detail the specific (other) software and hardware	\bullet More realistic examples would go into rather extensive details,
• for the platform on which the software	• listing hardware and software product names, versions, releases, etc.
 is to be demonstrated to the customer — say for acceptance tests, or for management demos, or for user training 	
•	
R, Far +16 68 191 © Don Kgene, Failey 31, OS 201 Hile, Danash Evale, dallan davak, Spondignalane, Anelbywe 31, VII. walan davak /V	- H KST 272, Far - H KH KHY () Das Bjerns, Fashing 11, DN 201 Han, Danask Exash, Addresdar, A. Sperdigent an, Anthynesia (M. 1997)
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Distribution April 5. 2006, 13.05 Page 1344, Topic: 57, Tell: 62 Tochcar Schweity of Downst ####################################	Apri 5.206, 1365 Page 1842, Topic 57, Fail: 43 Tailord Tournes Fails, DC302 Replayed, Downsk In addition, as part of our wider concept of software, we also include
	• a comprehensive collection of supporting documents:
Characterisation 19.258 By documentation requirements we mean requirements of any of the software documents that together	* training manuals,
nake up software:	\star installation manuals,
\bullet not only $code$ that may be the basis for executions by a computer,	\star user manuals,
• but also its full development documentation:	* maintenance manuals, and
\star the stages and steps of application domain description,	\star development and maintenance logbooks
 ★ the stages and steps of requirements prescription, and ★ the stages and steps of software design prior to code, 	. •
with all of the above including all <i>validation</i> and <i>verification</i> (incl., <i>test</i>) <i>documents</i> .	
ENCREERING Donates, Registerents and Software Design Dates of Design Social of Compare Social of Compa	OF TWISE ENCIREERING: Domains, Respiraments and Software Design Volume 3 Experiments and software or depending.
metatika Regulamenta Industria Udunukai	0.6.8 Diseasion Machine Requirements Intel (2014) April 5, 2006, 13.05 Page 1844, Topic 57, Toil: 65 Richer Neman Pale, Dissa R Reme(db)(Vall1)(26.10)(26.10) Page 1844, Topic 57, Toil: 65 Richer Neman Pale, DIS300 Paga 1946, Dissa R
• We do not attempt, in our characterisation, to detail what such / documentation requirements could be.	Discussion: Machine Requirements
 Such requirements could cover a spectrum from the simple presence, as a delivery, of specific ones, 	• We have — at long last — ended an extensive enumeration, explication and, in many, but not all cases, exemplification, of machine requirements.
\star to detailed directions as to their contents, informal or formal.	• When examples were left out it was because the reader should, by now, be able to easily conjure up such examples.
	• The enumeration is not claimed exhaustive.
	• But, we think, it is rather representative.
	• It is good enough to serve as a basis for professional software engineering.
	• And it is better, by far, than what we have seen in "standard" software engineering textbooks.
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[Topic 58]	• We shall remind the course student to review these four subsections.
Composition of Requirements Models	We shart remna the course student to review these rour subsections.They tell you a lot about how to document the requirements,
General	 They ten you a fot about how to document the requirements, as basically a set of four more or less separate subdocuments,
	 as basically a set of four more or less separate subdocuments, whether informally, as a narrative,
• In various "Domain Facet" parts of these past lectures	whether informally, as a narrative,or formally, as an annotated formal definition.
Document".	
$Document$ ". • Here \mathcal{X} stood for either	
Document". • Here X stood for either ★ BPR,	
Document". • Here X stood for either ★ BPR, ★ Domain Requirements,	
• Here \mathcal{X} stood for either \star BPR,	

RE ENGINEERING: Domains, Requirements and Software Design Volume 3 Departures of Computer Sciences and Engineering Institute of Indevanities and Modeling Tetral	OFTWARE ENGINEERING: Domains, Requirements and Software Design Volume 3 Department of Corporate Science and Engineering (Science and Engineering (
/3d18/3d16v April 5, 2006, 11:05 Page 1847, Tepic: 59, Feil: 1 Richard Passes Paid, Dr.300 Kp.Legit, Danak	8.21 Gennel International Mathing Technical Ma
Topic 59	• This does not mean that one could not furnish such examples.
Discussion: Requirements Facets	• We have chosen not to show such examples for three reasons:
General	\star First, the examples would be somewhat long.
ave covered the three main facets of requirements models:	* Second, such examples have already been shown in other
in requirements,	lectures.
terface requirements and	\star But, more important, we still, as of 2006, lack appropriate
achine requirements.	formal techniques and tools.
ourse student who studies this volume on the basis of emphasising the	• But we observe, today, steady and impressive progress in formal
techniques	techniques and tools for expressing machine requirements.
have noted that there were rather few, if any, formalised examples. s was especially true for the machine requirements.	
was especially true for the machine requirements.	
(c) Diver Rigners, Fredwig 11, DN: 2009 Hilton, Dawnack E-washt: de-Bernelloude, ligener-Biguel Long, daweithgioner bit; URL: www.inn.db.th/?db	
i: Domains, Requirements and Software Design Volume 3 Department of Compare discussed Experiments Toth Institute of Informatics and Extensional Multility	OFTWARE ENGINEERING, Domains, Requirements and Software Design Volume 3 Department of Computer Science and Engineering Designment of Memorical Mediation of Memorical Mediation
Tools Institute of Montesical Mediating April 5, 2006, 13.05 Page 1849, Topic: 59, Foil: 3 Richard Preverse Page 1649, KK 50, 500 Kg Lydy, Drevark	9.8.2 Principles, Techniques and Tools Techniques and America's Mathematica and Manuscraft Mathematica and
Principles, Techniques and Tools	Techniques 59 Requirements Facets: The techniques fall, as usual,
	into two classes:
ple 19.88 Requirements Facets: "Divide and Conquer":	• the informal techniques, which
t a "separation of concerns" principle; hence	\star cover all the so-far-covered informal techniques of
el	* rough-sketching, terminologisation and narration;
lomain,	• and the formal techniques,
nterface and	\star which. likewise, cover all the so-far-covered formal techniques of
machine	* which he while, cover an the so-fai-covered formal techniques of * formal abstraction and modelling
uirements separately, as near so as possible	x formal abstraction and moderning
	•
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(c) Dave Righten, stretting 11, 105-2019 States, Downark Found and differending disconfiguration, desetBipmen 20, URL: www.inen.doc.dh/?db	- ree war 2021 bit - 66 681 6019 () Const Lipered pail Long Lipered pail Lipered pail Lipered pail Long & Genedia de Lipered pail Long & Genedia de Lipered pail Long & Genedia de Lipered pail Lipere
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and Tools Their difference of the second diffe	
April 5, 2006, 13.05 Page 1851, Topic: 50, Foll: 5 Richard Pressues Plate, 07.0308 KpL aregin, Consust	
19.23 Requirements Facets: The tools, like the techniques, fall, as usual, / classes:	
informal tools, which include	
ordinary text-processing tools	
* with extensive cross-referencing	
and database storage facilities;	
nd the formal tools, which include	

\$ syntax editors, type checkers,
\$ verification, model checking and test tools, and so on

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