Lecture 2: Domains

2. Domains

- By an observable phenomenon we shall here understand something that can be sensed by one or more of our five sense organs.
- By a domain we shall here informally understand
  - an area of human activity
  - characterised by observable phenomena:
    - entities and their
    - properties,
  - and abstractions, i.e., concepts, thereof.
- In Part 2.2 we suggest a more formal way of characterising a domain.
- But first we give some rough sketch hints as to what domains are.

2.1. Informal Characterisation

- There are several forms of observable phenomena.
- There are the entities:
  - **endurant** entities: **parts**,
  - and **perdurant** entities:
    - ∗ **actions**,
    - ∗ **events**, and
    - ∗ **behaviours**

  of the domain.
- Then there are the properties of these entities:
  - (i) their **unique identifications**,
  - (ii) the **mereology** of parts, and
  - (iii) the **attributes** of
    - ∗ parts: types and values, whether atomic or composite, and of
    - ∗ actions, events and behaviours: signatures and values.

- We will just examine one of the part properties.

2.2. Mereology

- Mereology, to us, is the study and knowledge
  - about how physical and conceptual parts relate and
  - what it means for a part to be related to another part:
    - being *adjacent* to,
    - being *contained* properly within,
    - being *overlapped* (i.e., *sharing*) properly with,
    - etcetera.

- By physical parts we mean
  - such spatial individuals
  - which can be pointed to.
- **Examples:**
  - *a road net*
    (consisting of street segments and street intersections);
  - *a street segment*
    (between two intersections);
  - *a street intersection;*
  - *a vehicle; and*
  - *a platoon*
    (of sequentially adjacent vehicles).

- By a conceptual part we mean
  - an abstraction with no physical extent,
  - which is either present or not.
- **Examples:**
  - *a bus timetable*
    - *(not as a piece or booklet of paper,*
    - *or as an electronic device, but)*

    as an image in the minds of potential bus passengers; and
  - *routes of a pipeline, that is, adjacent sequences of pipes, valves, pumps, forks and joins, for example referred to in discourse: take "such-and-such" a route".*
  - The tricky thing here is that a route may be thought of as being both a concept or being a physical part — in which case one ought give them different names: a planned route and an actual route, for example.

- The mereological notion of subpart, that is: *contained within* can be illustrated by **examples:**
  - *the intersections and street segments are subparts of the road net;*
  - *vehicles are subparts of a platoon; and*
  - *pipes, valves, pumps, forks and joins are subparts of pipelines.*
- The mereological notion of adjacency can be illustrated by **examples:**
  - *the pipes of a pipeline are adjacent (that is, connected) to other pipes or valves or pumps or forks or joins, etcetera;*
  - *two immediately neighbouring vehicles of a platoon are adjacent.*
  - *We shall mereologically model adjacency by the mereology notion of overlap.*

- The mereological notion of proper overlap can be illustrated by **examples:**
  - *two routes of a pipelines may overlap; and*
  - *two conceptual bus timetables may overlap with some, but not all bus line entries being the same.*

2.3. Rough Sketch Hints of Domains

Example 5 (Domains) We present a number of examples:

- *Container Line:*
  - A container line consists of a number of *container vessels* capable of holding (usually thousands of) *containers* being transported, by the vessels, between *container terminal ports* across the seven seas.
  - A container vessel has its containers ordered in *bays*, *rows*, and *stacks* with *container terminal port cranes* depositing or removing ("lifting") *containers* onto or from port side *stack tops*.
  - Container vessels sail specific *routes* with a route being designated by a sequence of *container terminal port visits* where a *container terminal port visit*, amongst others, has a *container terminal port name*, *estimated and actual arrival times*, etc.
  - Etcetera.

- *Financial Service Industry:*
  - A financial service industry consists of a number of *"high street" (i.e., deposit/demand) banks*, *savings & loan institutes*, *commercial banks*, other forms of banks, *insurance companies* (of differing specialisations), *stock/commodity exchanges* with their *brokers* and *traders*, one or more forms of *finance "watchdog" institutions* (SEC, FDIC, etc.), etc.
  - A *bank* had *clients* and *clients* have one or more *accounts* having *account numbers* and *account balances* with *clients opening* and *closing accounts*, *depositing monies* into, and *withdrawing monies* from *accounts*, etc.
  - Etcetera.

- *Health Care System:*
  - A health care system consists of a number of *private physicians*, *hospitals*, *pharmacies*, *health insurance companies*, a *pharmaceutical industry*, *patients*, etc.
  - A *hospital* consists of a number or *wards* (etc.) with each *ward* consisting of a number or *bedrooms* (etc.) with each *bedroom* consisting of a number of *beds* (etc.), etcetera.
  - Etcetera.

- *Pipeline System:*
  - A pipeline system consists of sequences of units: pumps, pipes, valves, forks and joins such that a fork connects to one pipe at the input and two at the output and a join connects two pipes at the input and one at the output, such that the first unit is a pump and is connected at the input to a well and the last unit is a valve and is connected to a sink at the output.
  - A pump, when active (i.e., pumping) should be moving a certain volume of gas or liquid from the input to the put per time unit.
  - A valve when closed prevents flow of gas or liquid from the input to the put, whereas when open unhindered permits such a flow.
  - Etcetera.

- *Transportation System:*
  - Transportation involves, say, three sub-domains: a transport net, a fleet of vehicles, and a community of vehicle drivers and vehicle passengers.
  - A transport net consists of hubs and links such that a link is connected to exactly two distinct hubs and a hub is connected to zero, one or more links.
  - Vehicles are positioned along the net: at hubs or on links and may be standing still or moving — while transporting freight, the driver and zero, one or more passengers.
  - Etcetera.

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2.4. What are Domains ?

- So what is a domain ?
- We can answer this in three ways:
  - as above, by giving examples,
  - or, as we now do,
    - by an informal characterisation, or
    - by a more formal characterisation.

2.4.1. An Informal Characterisation of Domains

- A *domain* is a set of observable entities and abstractions of these, that is, of
  - *parts*
    (some of which form states),
  - *actions*
    (operation applications causing state changes),
  - *events*
    ("spurious" state changes not [intentionally] caused by actions) and
  - *behaviours*
    (seen as set of sequences of sets of actions, events and behaviours).

- Whereas some entities are manifested
  - spatio-physically, that is,
  - we can point to them,
- others cannot,
  - they are either abstractions of parts,
  - or they are actions, events and behaviours.
- These latter can, however, be characterised
  - by function definitions, event predicates and behaviour definitions
  - which [when applied] denote actions, events and behaviours.

2.4.2. A Formal Characterisation of Domains

- A domain is a behavioural algebra described as consisting of
  - usually two or more type descriptions,
  - usually two or more function and event descriptions, and
  - usually one or more behaviour descriptions,
    - which contain channel descriptions and
    - behaviour process descriptions.

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2.5. Six Examples

2.5.1. Air Traffic

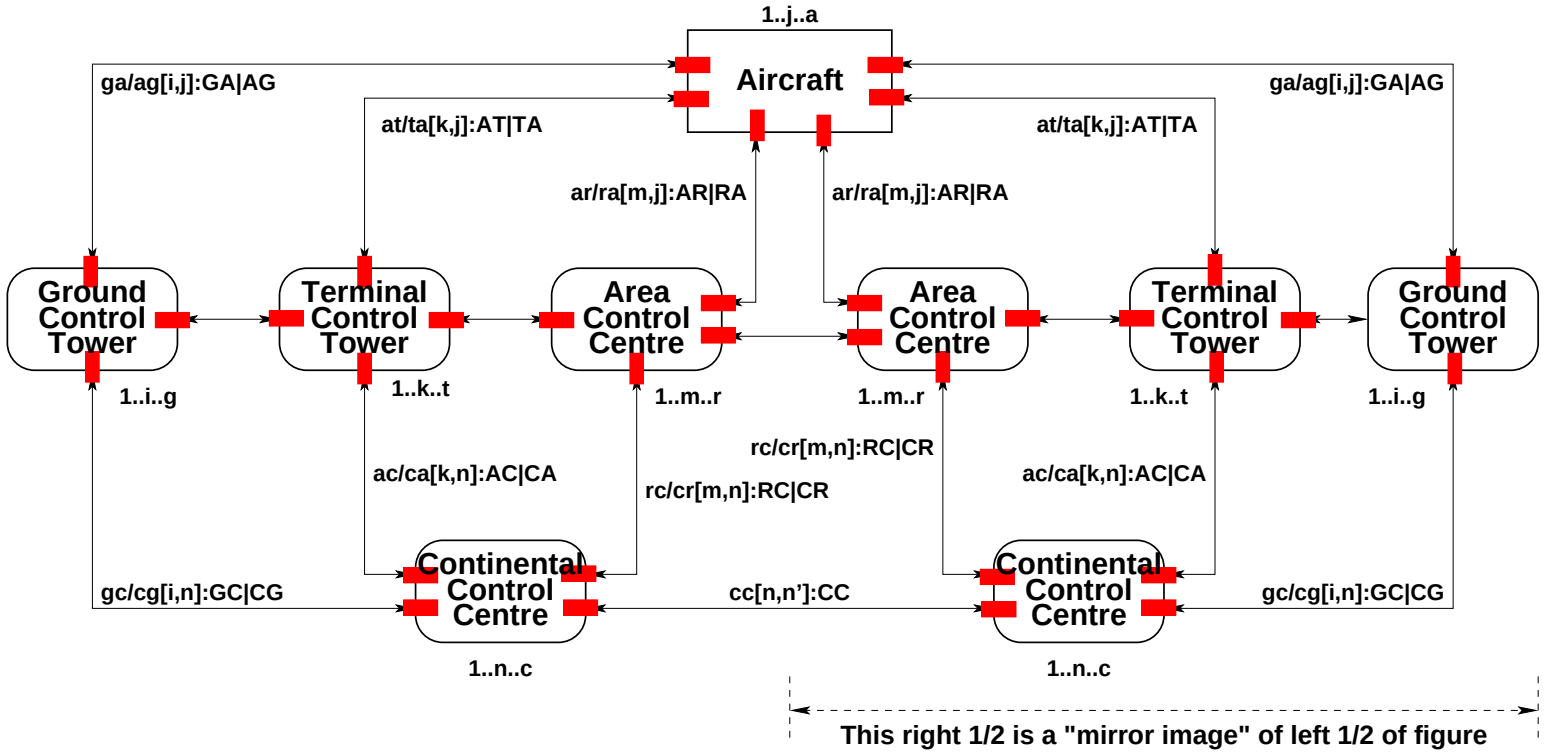

Figure 1: An air traffic system

2.5.2. Buildings

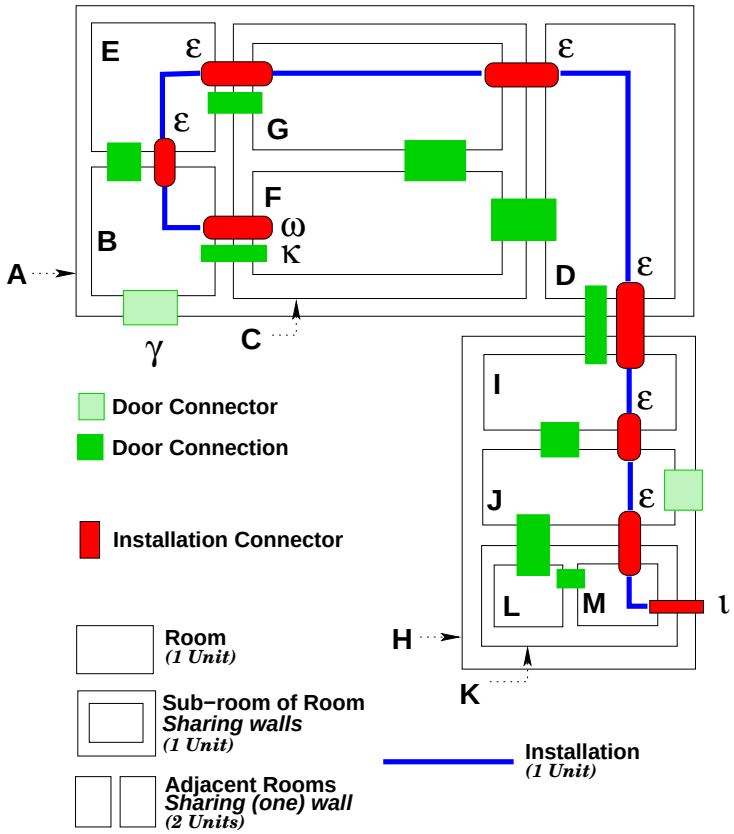

Figure 2: A building plan with installation

2.5.3. Financial Service Industry

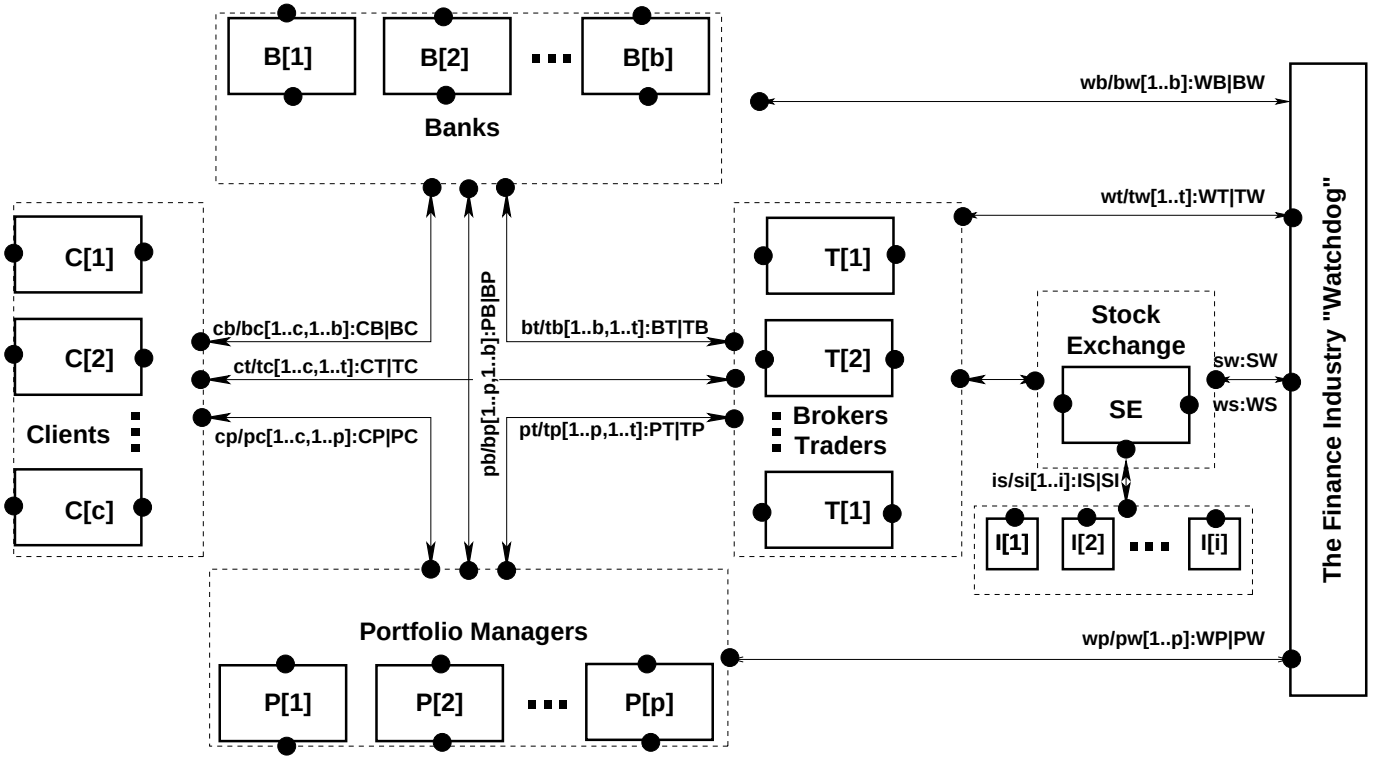

Figure 3: A financial service industry

2.5.4. Machine Assemblies

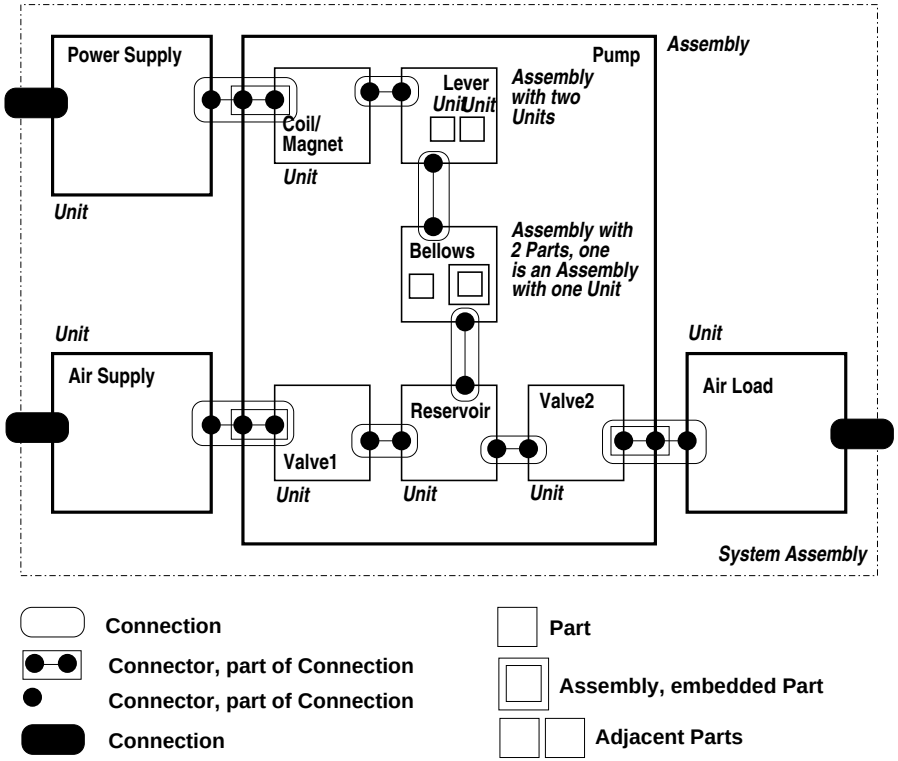

Figure 4: An air pump, i.e., a physical mechanical system

2.5.5. Oil Industry

2.5.5.0.1. "The" Overall Assembly

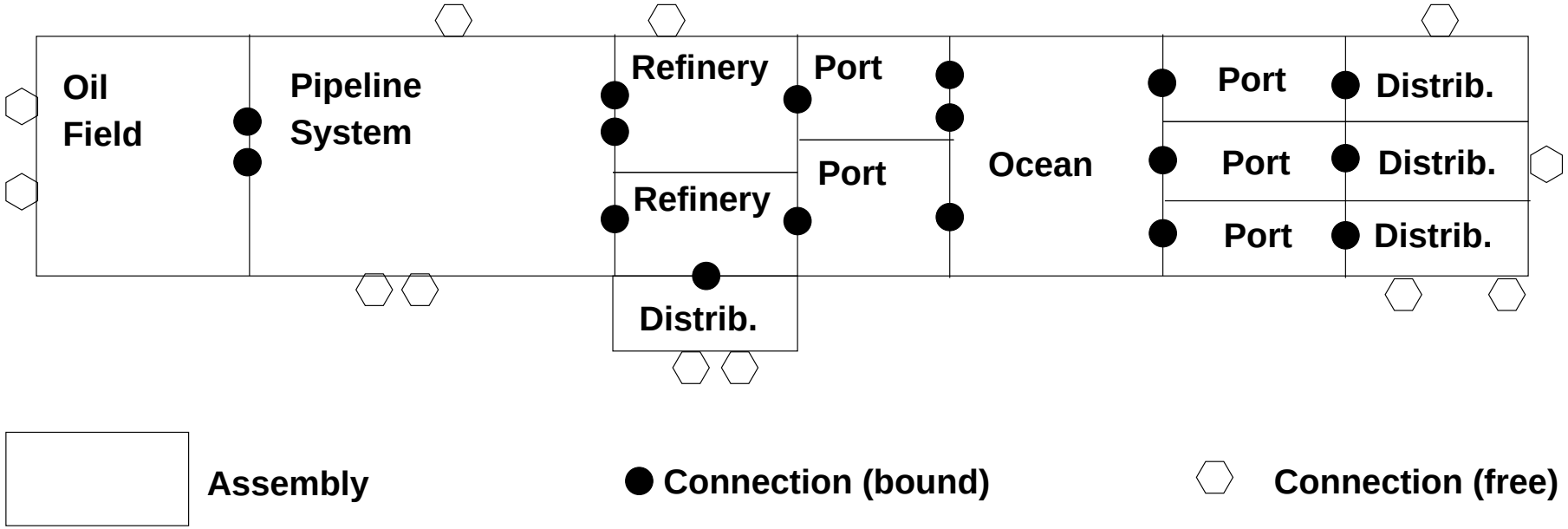

Figure 5: A Schematic of an Oil Industry

2.5.5.0.2. A Concretised Composite parts

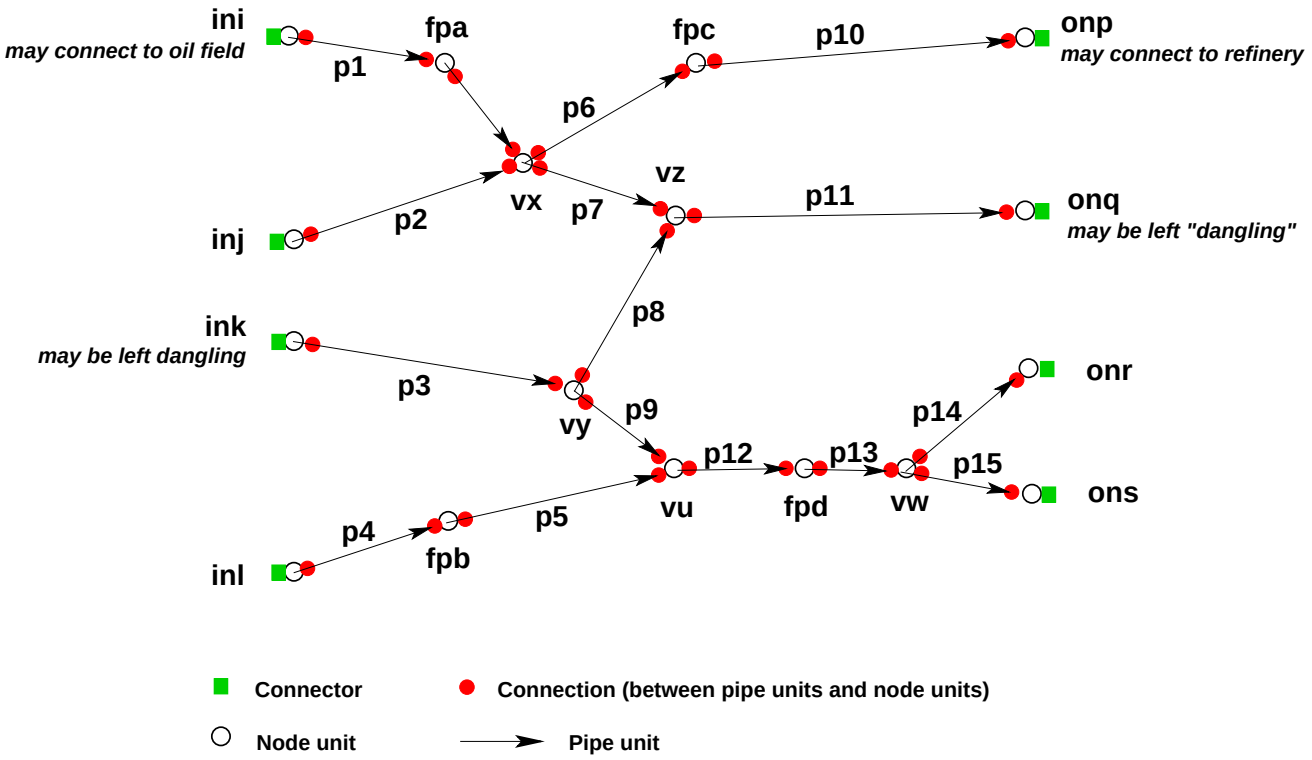

Figure 6: A Pipeline System

2.5.6. Railway Nets

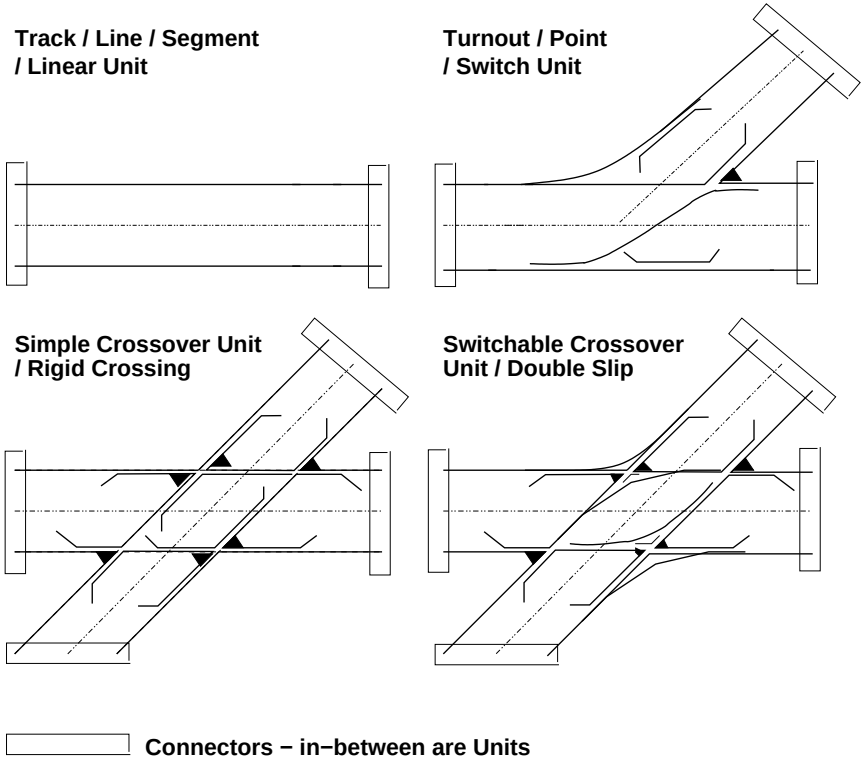

Figure 7: Four example rail units

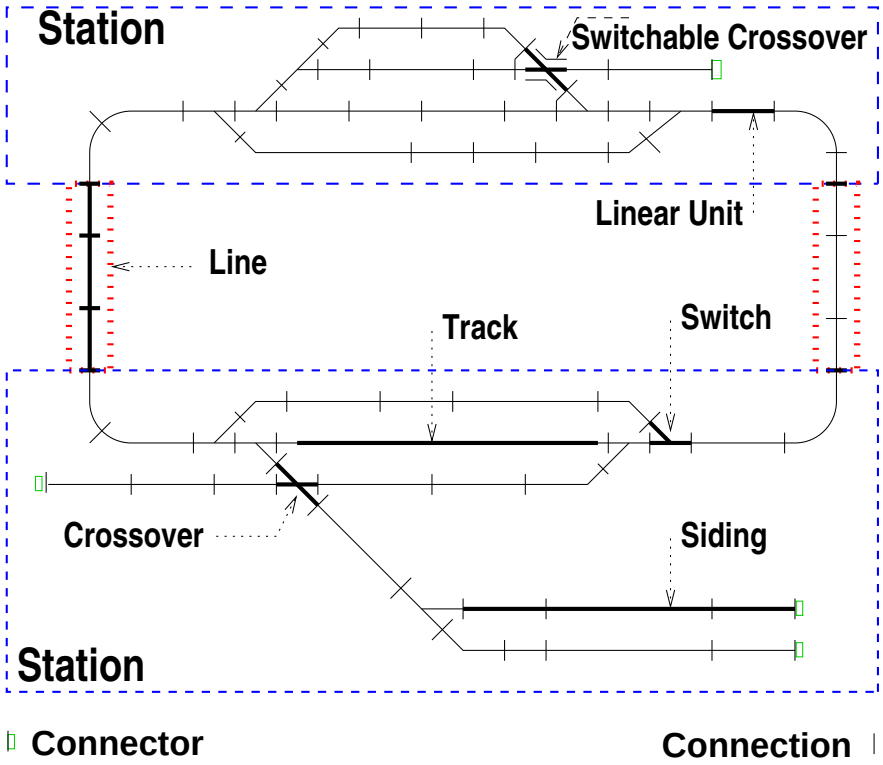

Figure 8: A "model" railway net. An Assembly of four Assemblies:
Two stations and two lines; Lines here consist of linear rail units;
stations of all the kinds of units shown in Fig. 7 on the preceding page.
There are 66 connections and four "dangling" connectors

End Lecture 2: Domains