ECE444: Software Engineering

Architecture2: Patterns, and Tactics

Shurui Zhou

The Edward S. Rogers Sr. Department of Electrical & Computer Engineering
UNIVERSITY OF TORONTO

Learning Goals

- Use notation and views to describe the architecture suitable to the purpose
- Document architectures clearly, without ambiguity
- Understand the benefits and challenges of traceability.
- Understand Architecture in Agile

Architecture vs Object-level Design

Design

- Design process (analysis, design, implementation)
- Design goals (cohesion, coupling, information hiding, design for reuse, …)
- Design patterns (what they are, for what they are useful, how they are described)

Levels of Abstraction

- Requirements
  - high-level “what” needs to be done
- Architecture (High-level design)
  - high-level “how”, mid-level “what”
- OO-Design (Low-level design, e.g. design patterns)
  - mid-level “how”, low-level “what”
- Code
  - low-level “how”

Design vs. Architecture

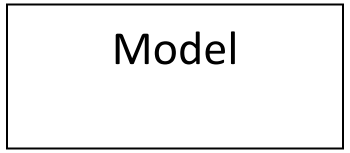
Design Questions

- How do I add a menu item in Eclipse?
- How can I make it easy to add menu items in Eclipse?
- What lock protects this data?
- How does Google rank pages?
- What encoder should I use for secure communication?
- What is the interface between objects?

Architectural Questions

- How do I extend Eclipse with a plugin?
- What threads exist and how do they coordinate?
- How does Google scale to billions of hits per day?
- Where should I put my firewalls?
- What is the interface between subsystems?

Objects



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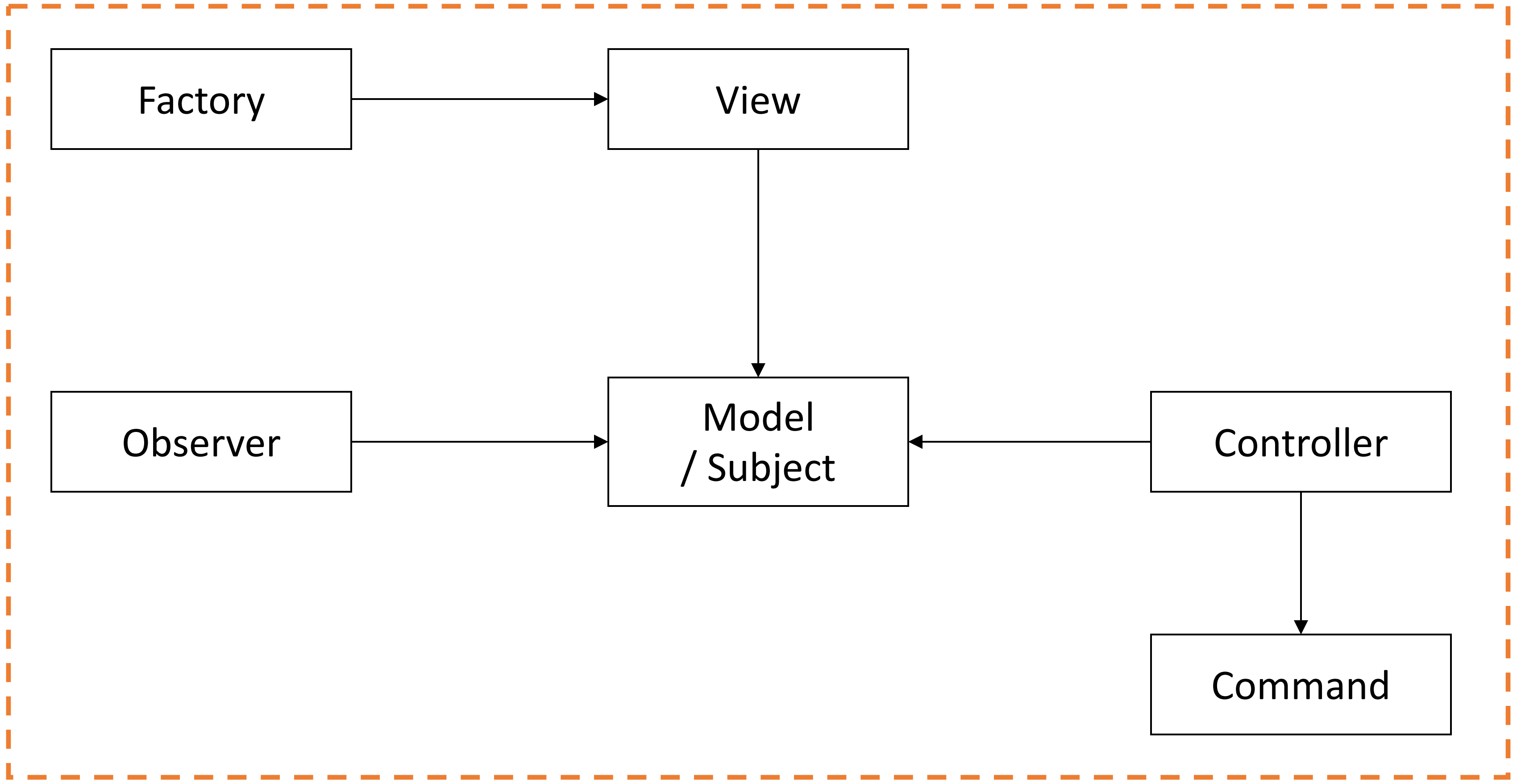
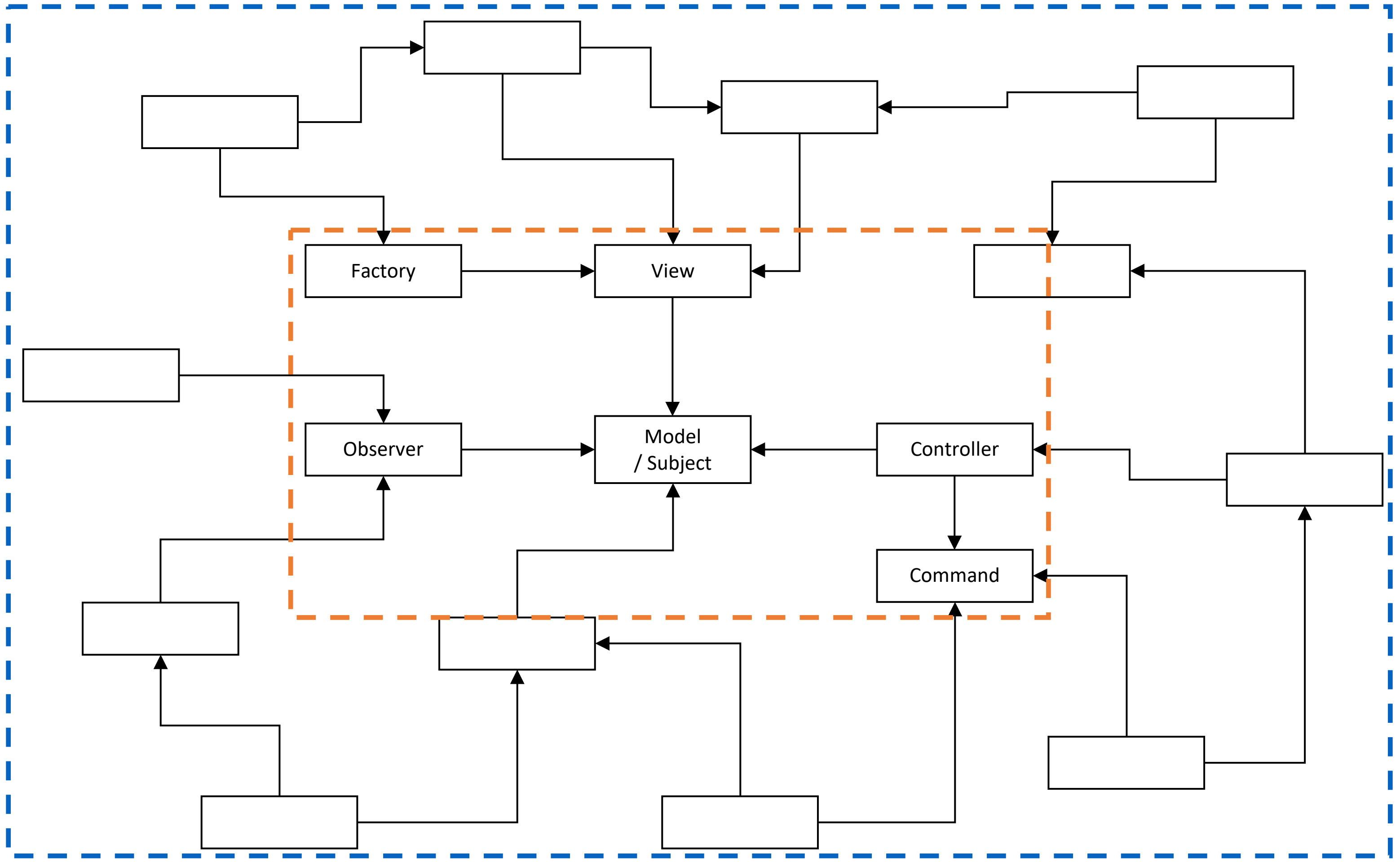
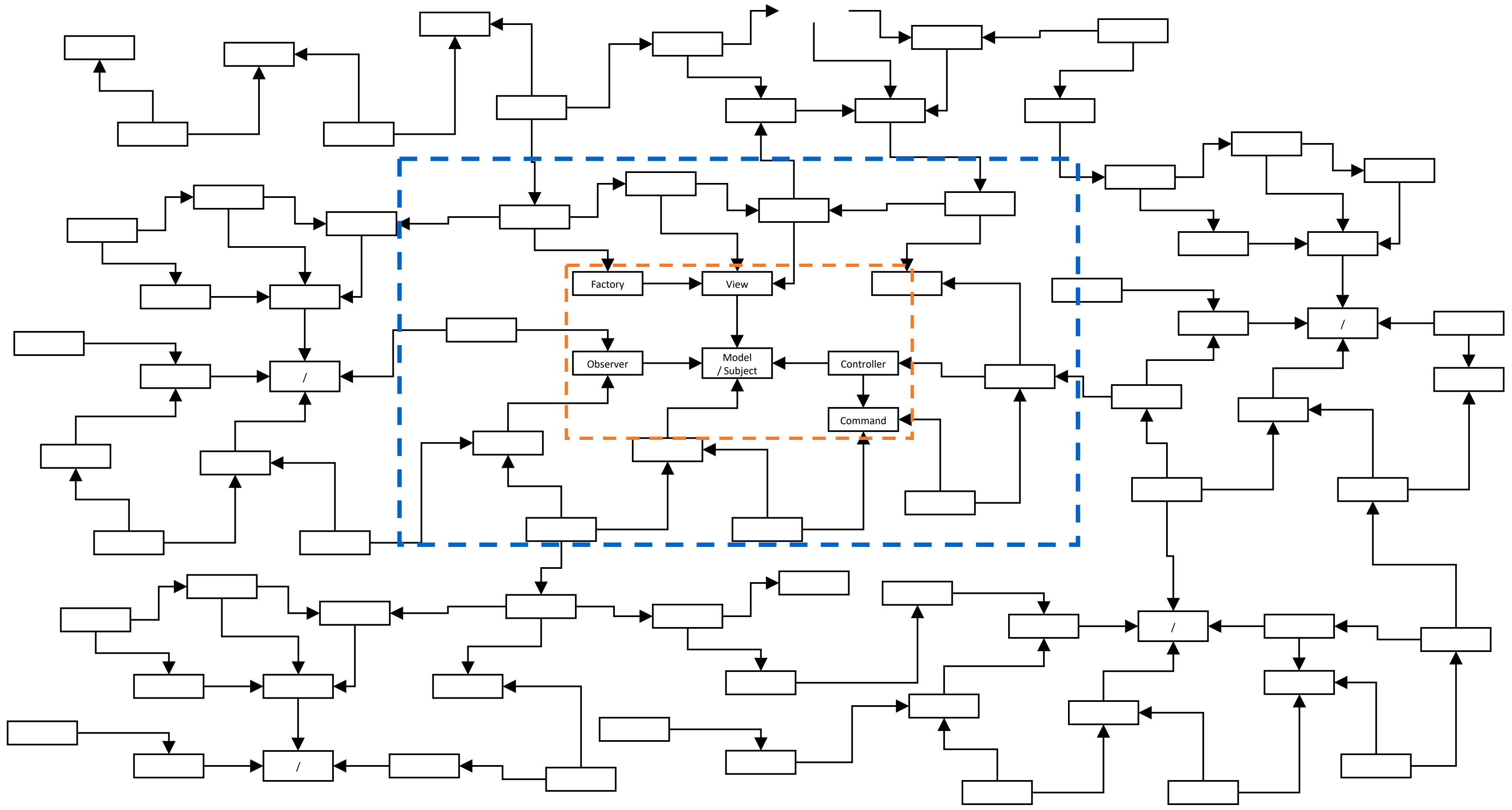
Design Patterns



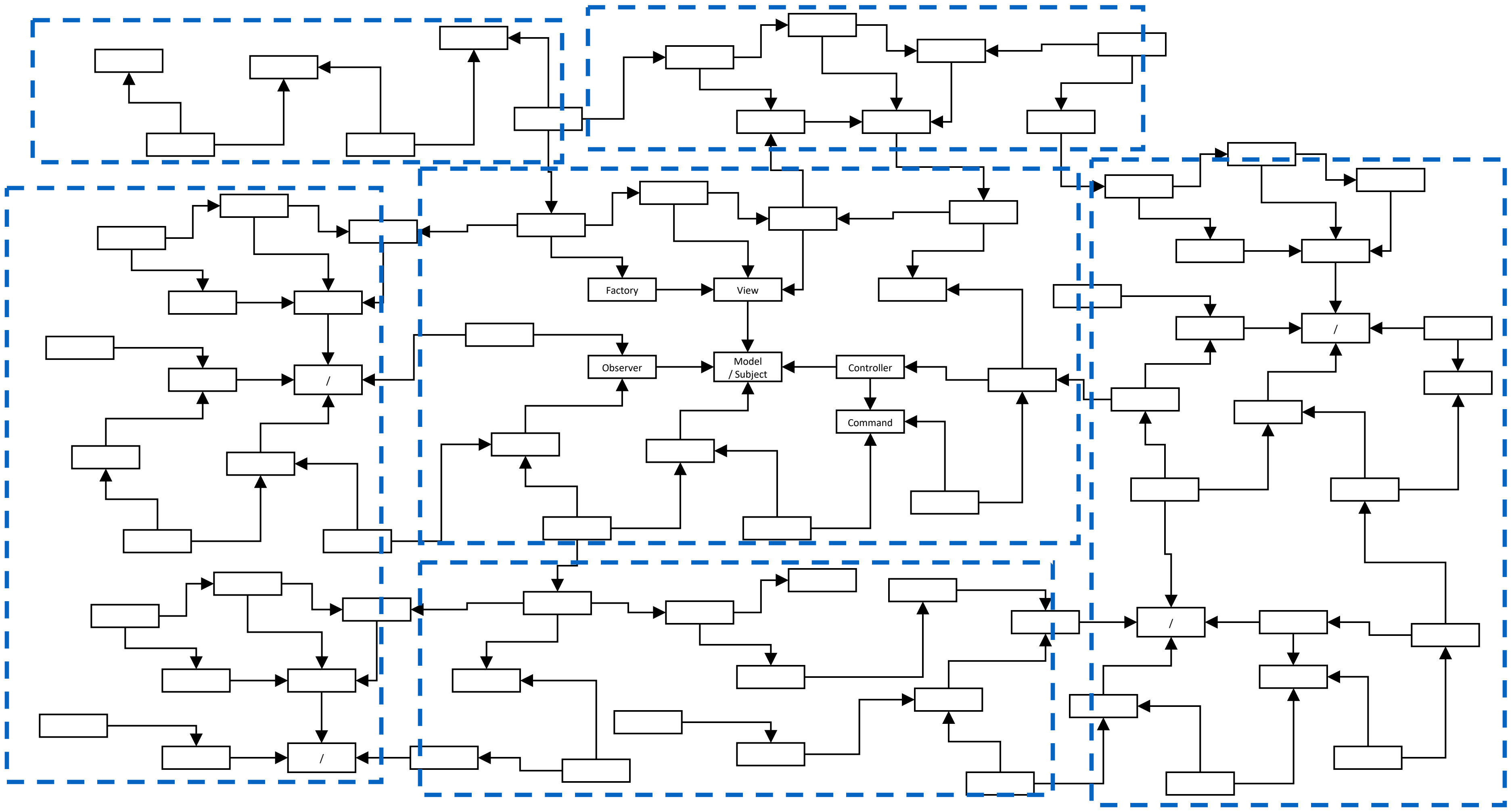
Design Patterns



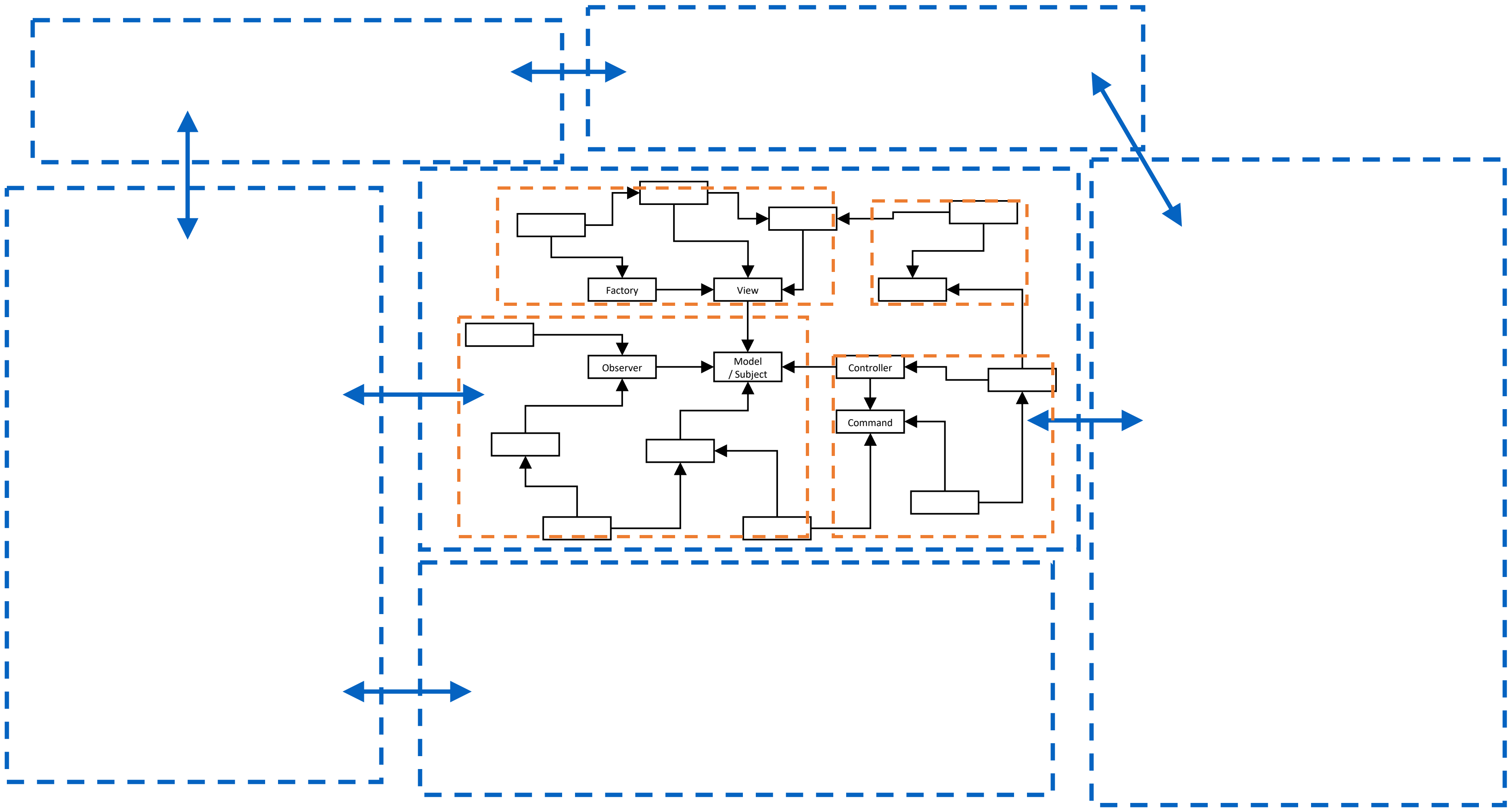
Design Patterns



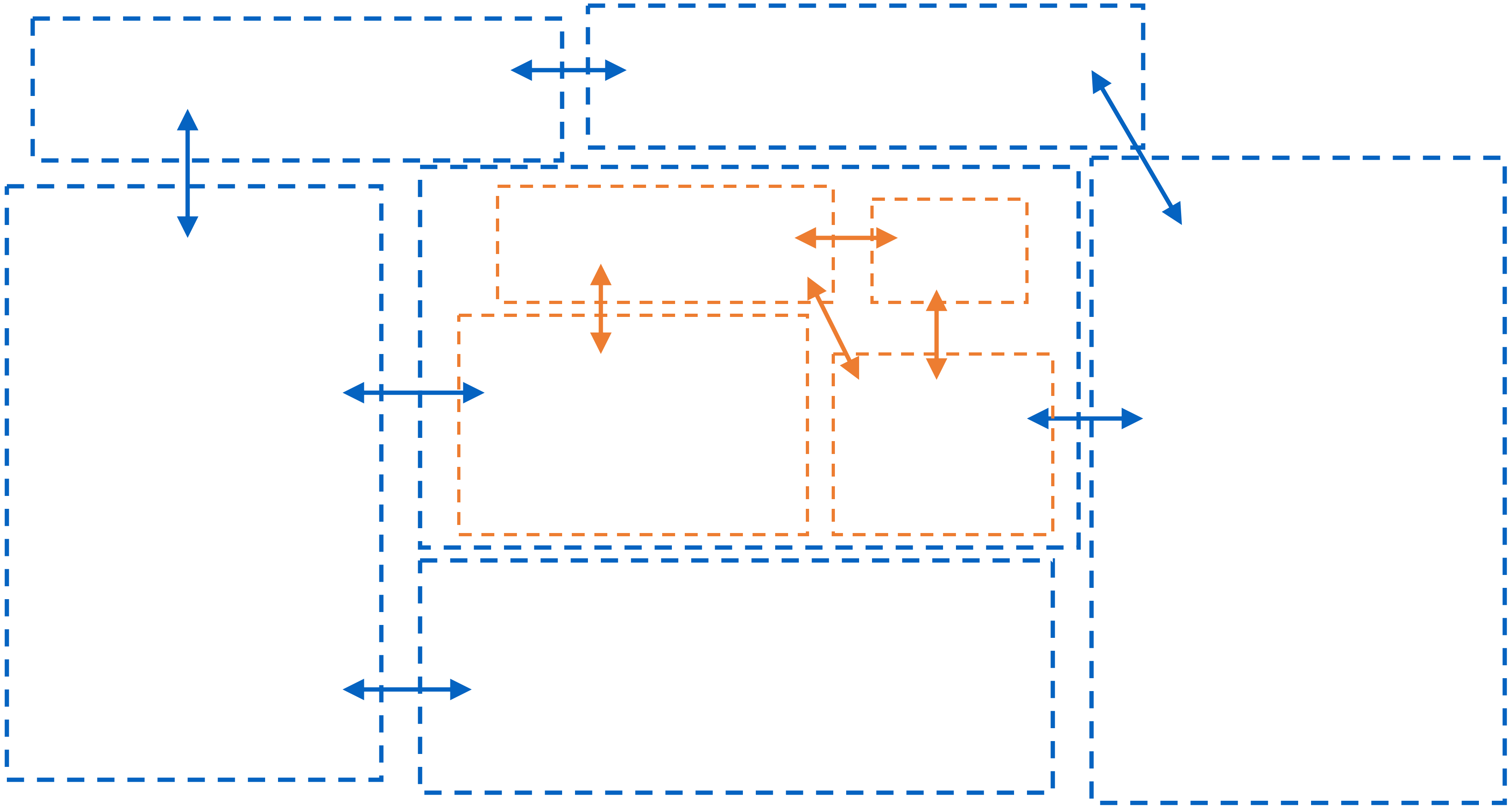
Architecture



Architecture

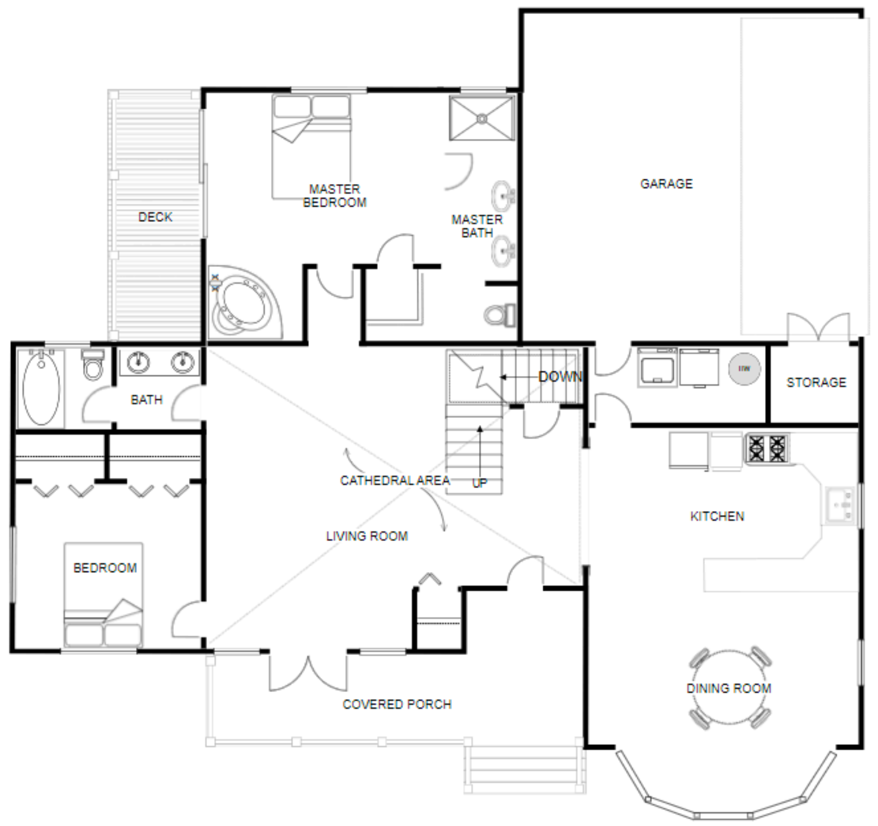


Architecture

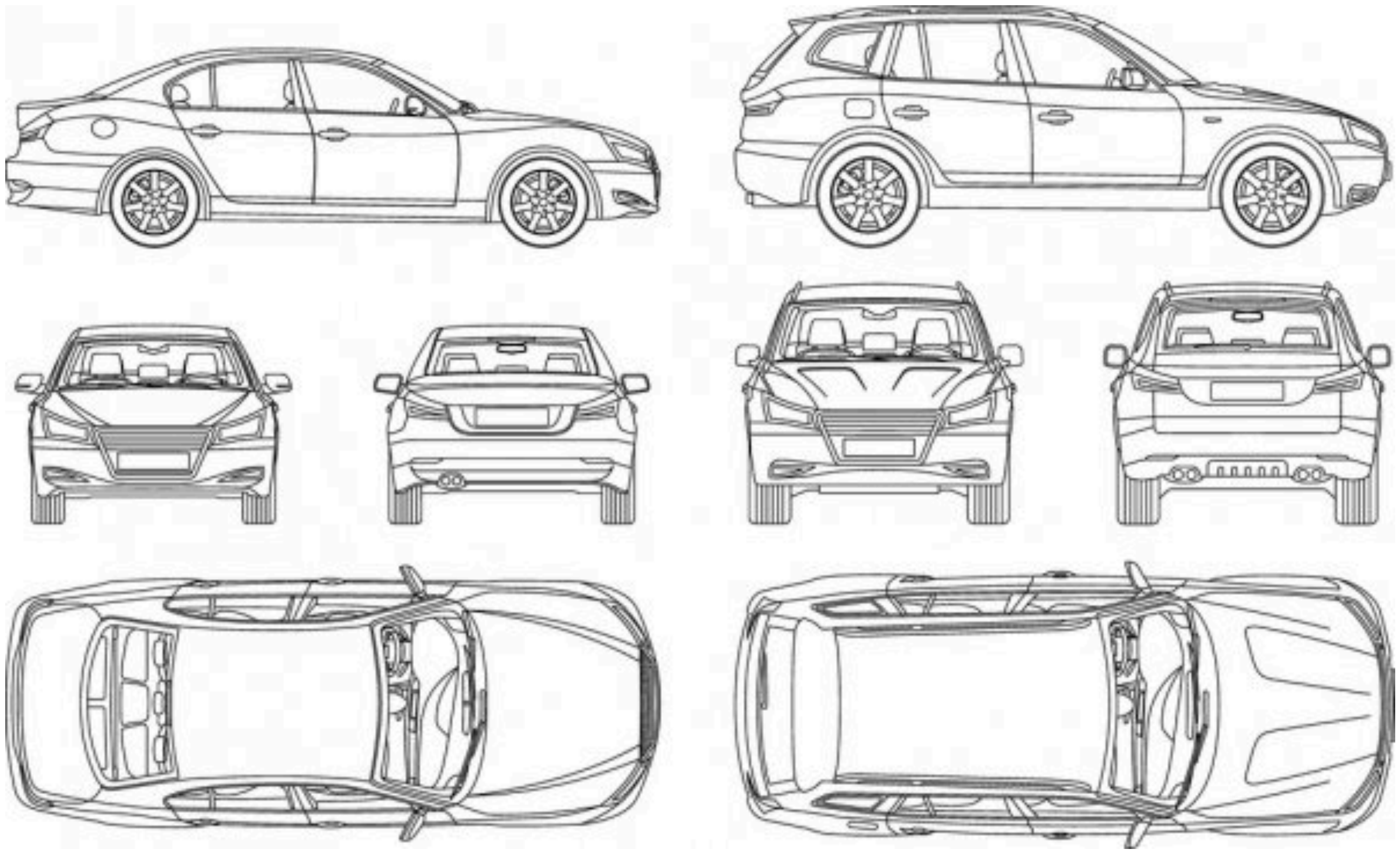


Architecture Documentation & Views

Every engineered artifact has an architecture



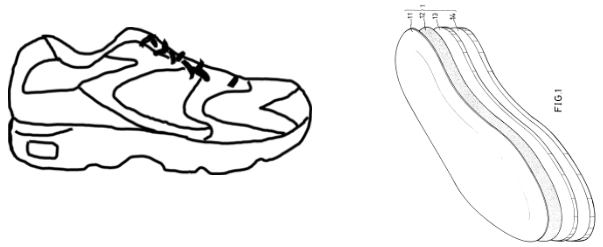
Blueprint



Architecture Disentangled

Architecture as
structures and relations
(the actual system)

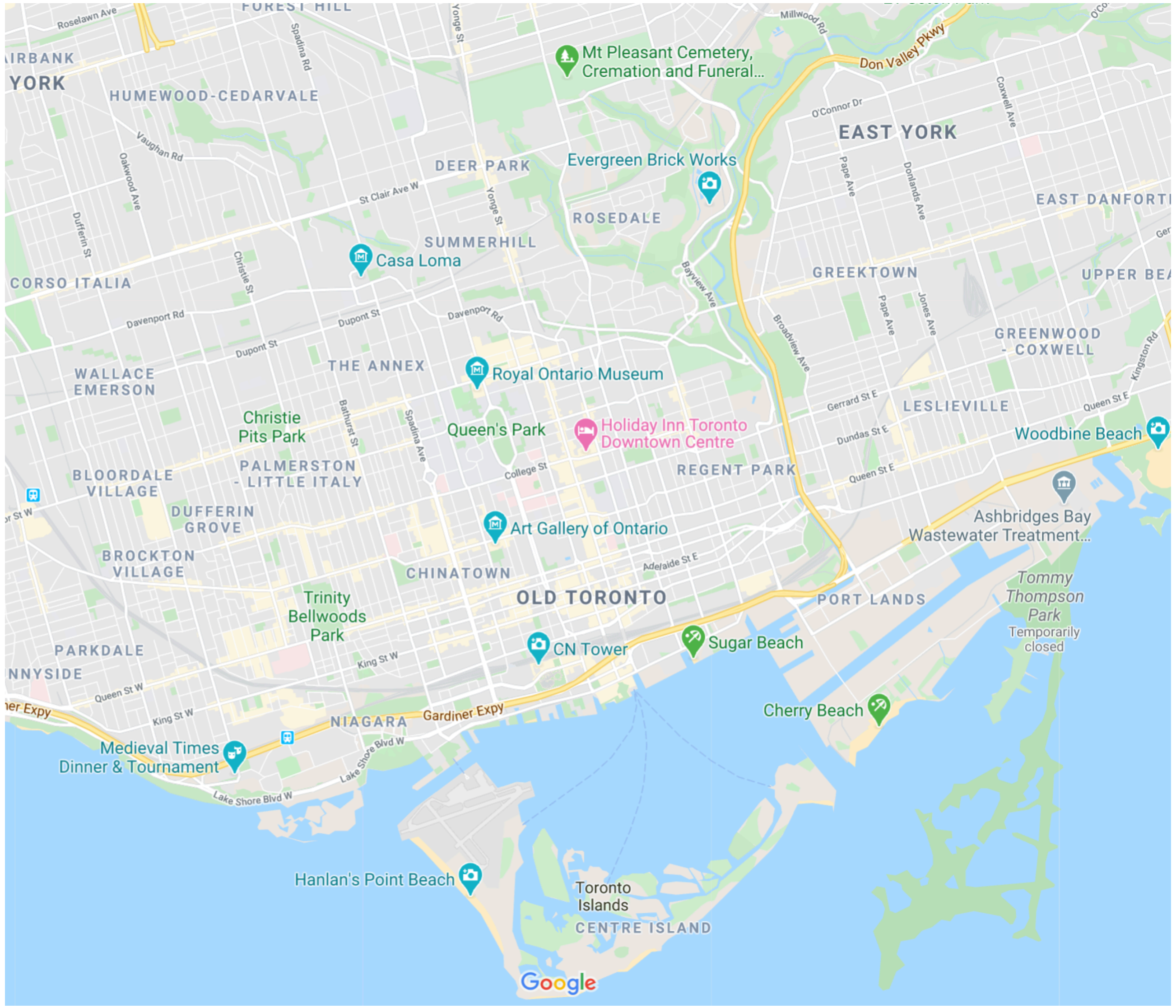
Architecture as
documentation
(representations of the system)

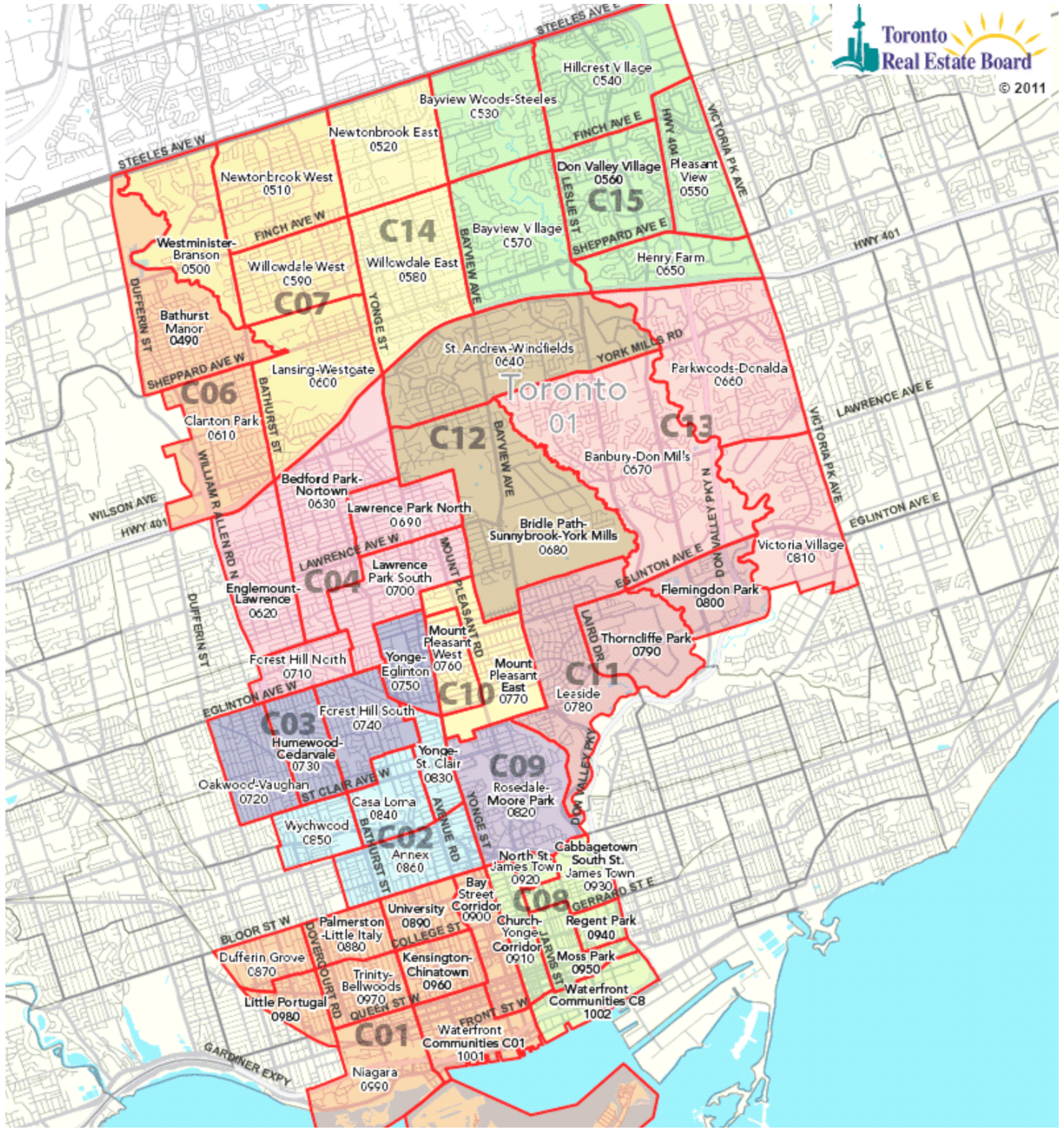


Architecture as (design) process
(activities around the other two)

Why Document Architecture?

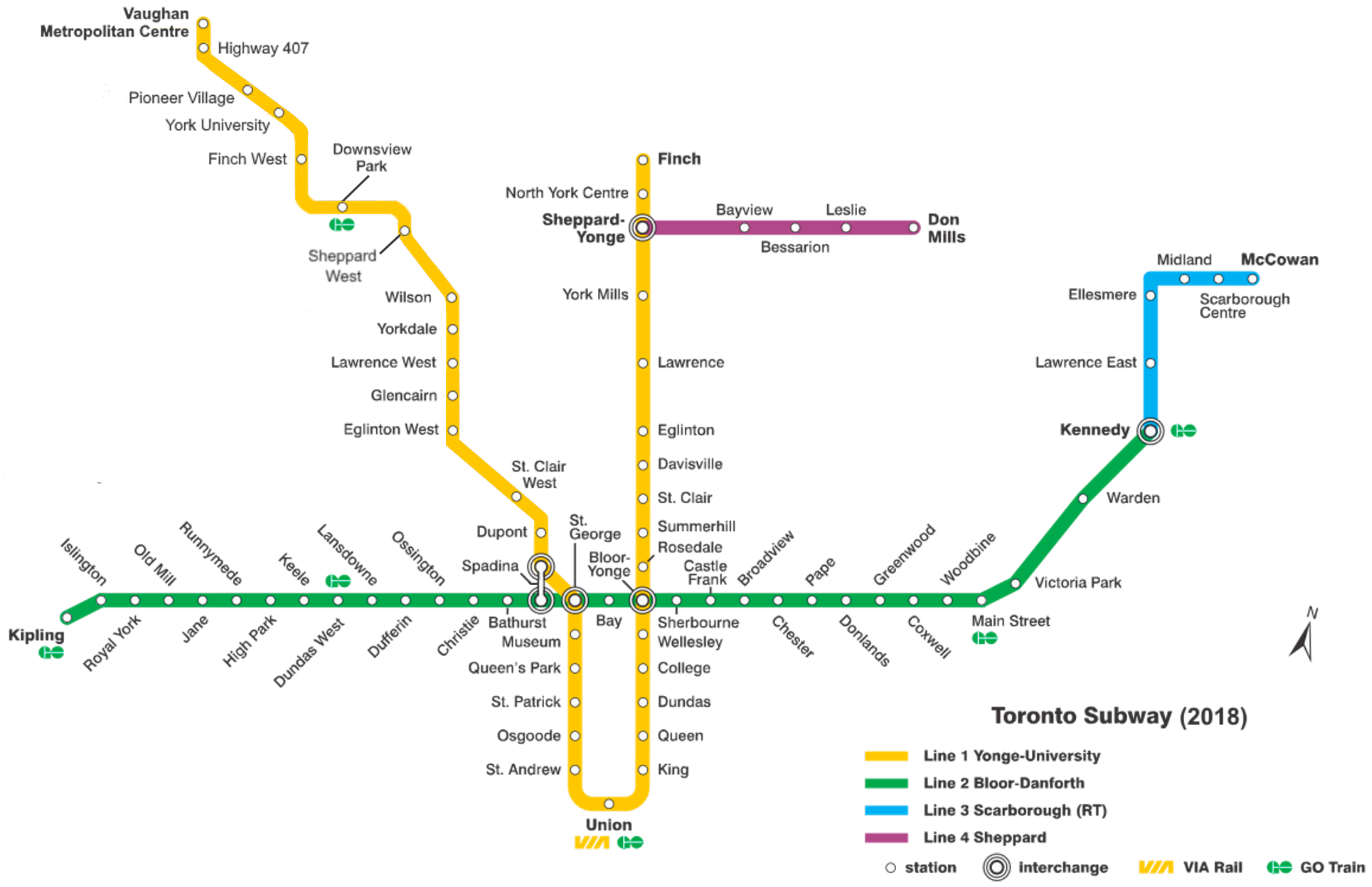
- Blueprint for the system
  - Artifact for early analysis
  - Primary carrier of quality attributes
  - Key to post-deployment maintenance and enhancement
- Documentation speaks for the architect, today and 20 years from today
  - As long as the system is built, maintained, and evolved according to its documented architecture
- Support traceability.


YORK
HUMEWOOD-CEDARVALE
FOREST HILL
Mt Pleasant Cemetery, Cremation and Funeral...
Don Valley Pkwy
EAST YORK
DEER PARK
Evergreen Brick Works
ROSEDALE
SUMMERHILL
Casa Loma
CORSO ITALIA
GREEKTOWN
EAST DANFORTH
UPPER BEACHES
GREENWOOD - COXWELL
THE ANNEX
Royal Ontario Museum
WALLACE EMERSON
Christie Pits Park
Queen's Park
Holiday Inn Toronto Downtown Centre
LESLIEVILLE
Woodbine Beach
BLOORDALE VILLAGE
PALMERSTON - LITTLE ITALY
REGENT PARK
DUFFERIN GROVE
Art Gallery of Ontario
Ashbridges Bay Wastewater Treatment...
BROCKTON VILLAGE
CHINATOWN
OLD TORONTO
PORT LANDS
Tommy Thompson Park
Temporarily closed
Trinity Bellwoods Park
CN Tower
Sugar Beach
PARKDALE
Gardiner Expy
NIAGARA
Cherry Beach
Medieval Times Dinner & Tournament
Hanlan's Point Beach
Toronto Islands
CENTRE ISLAND
Google



http://jackiecarron.com/real_estate/toronto/buyers_zone_maps.shtml

TORONTO
The Annex
The Junction
Harbord Village
8
3
Little Italy
Brockton Village
1
6
5
2
Little Portugal
Chinatown
High Park
Fashion District
7
4
9
LAKE ONTARIO


Vaughan Metropolitan Centre
Highway 407
Pioneer Village
York University
Finch West
Downsview Park
Sheppard West
Wilson
Yorkdale
Lawrence West
Glencairn
Eglinton West
St. Clair West
Dupont
Spadina
St. George
Museum
Queen's Park
St. Patrick
Osgoode
St. Andrew
Union
Finch
North York Centre
Sheppard-Yonge
Bayview
Bessarion
Leslie
Don Mills
York Mills
Lawrence
Eglinton
Davisville
St. Clair
Summerhill
Rosedale
Bloor-Yonge
Bay
Wellesley
College
Dundas
Queen
King
Kipling
Islington
Royal York
Old Mill
Jane
Runnymede
High Park
Keele
Dundas West
Lansdowne
Dufferin
Ossington
Christie
Bathurst
Sherbourne
Castle Frank
Broadview
Chester
Pape
Donlands
Greenwood
Coxwell
Woodbine
Main Street
Victoria Park
Warden
Kennedy
Lawrence East
Ellesmere
Midland
Scarborough Centre
McCowan
N
Toronto Subway (2018)
Line 1 Yonge-University
Line 2 Bloor-Danforth
Line 3 Scarborough (RT)
Line 4 Sheppard
station
interchange
VIA Rail
GO Train

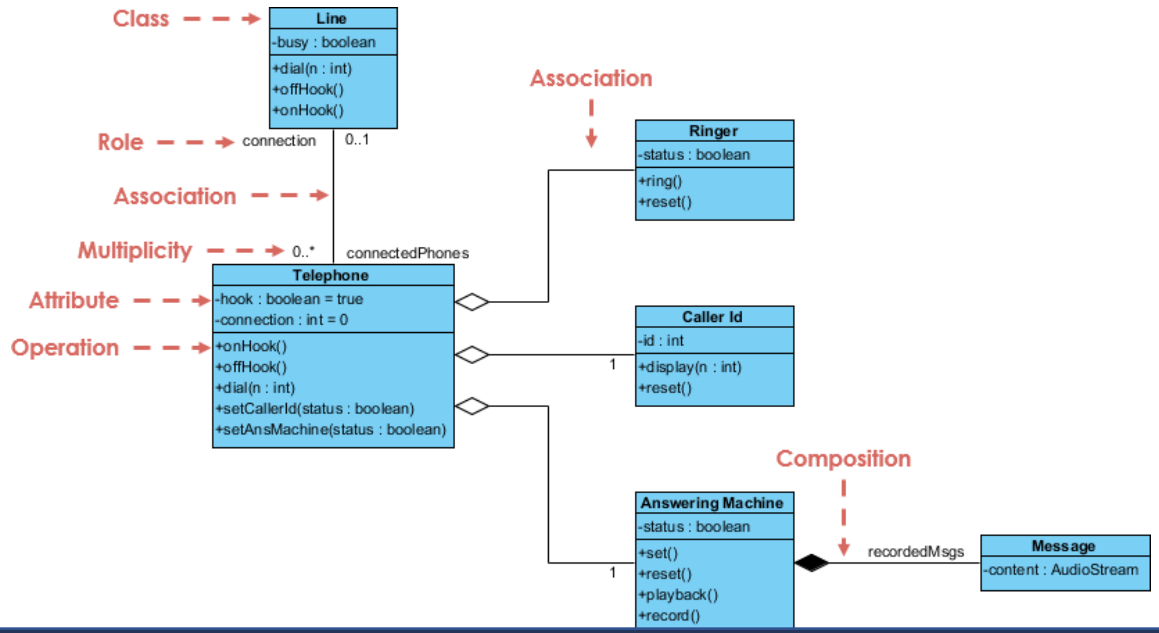
Common Views in Documenting Software Architecture

- Static View
  - Modules (subsystems, structures)
    and their relations (dependencies, …)
- Dynamic View
  - Components (processes, runnable entities) and connectors (messages, data flow, …)
- Physical View (Deployment)
  - Hardware structures and their connections

Common Views in Documenting Software Architecture

- **Modules** (Static)

Modules are assigned specific computational responsibilities, and are the basis of work assignments for programming teams



Architecture Is a Set of Software Structures

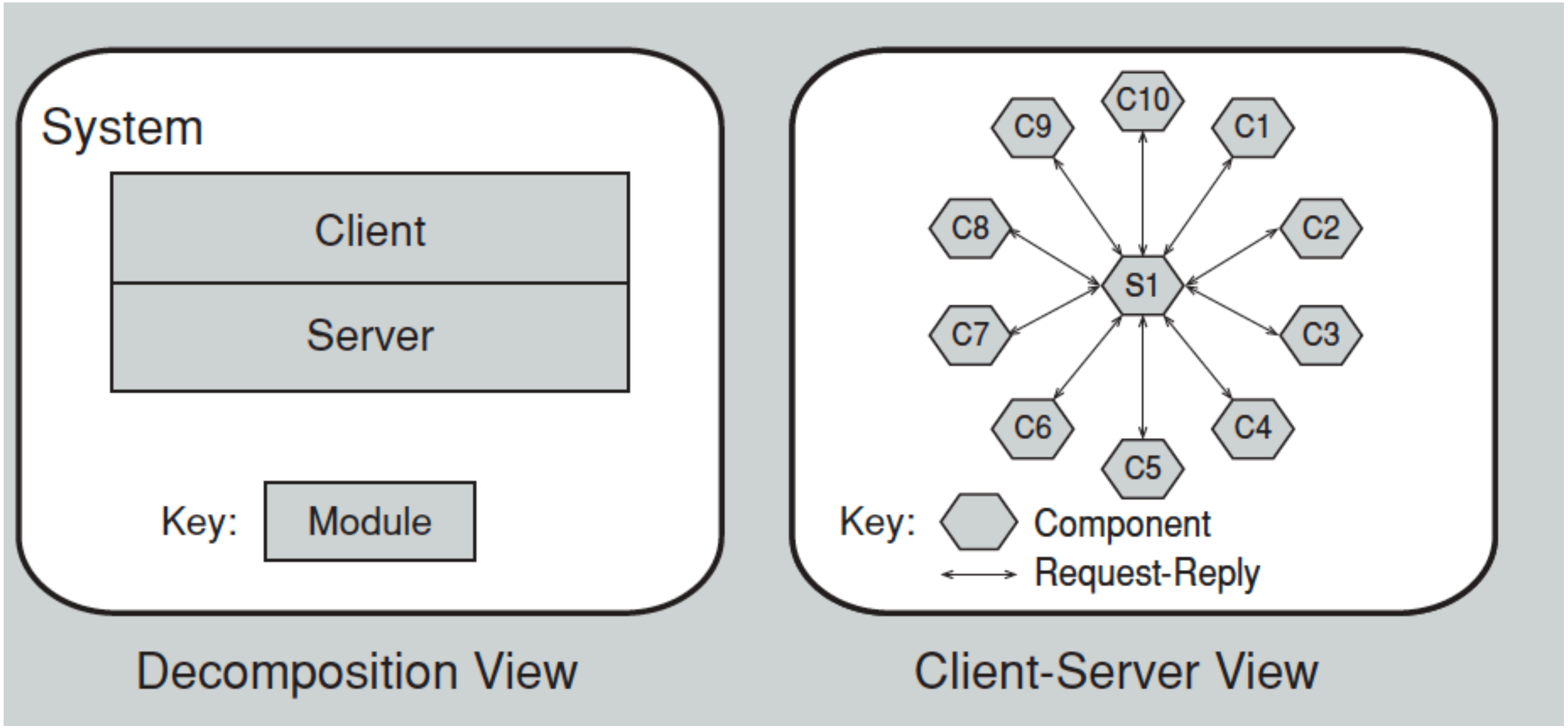
- **Modules** (Static)

Modules are assigned specific computational responsibilities, and are the basis of work assignments for programming teams

- **Dynamic** (Component-and-connector **C&C**)

Focus on the way the elements interact with each other at runtime to carry out the system's functions.

Two views of a client-server system



Common Views in Documenting Software Architecture

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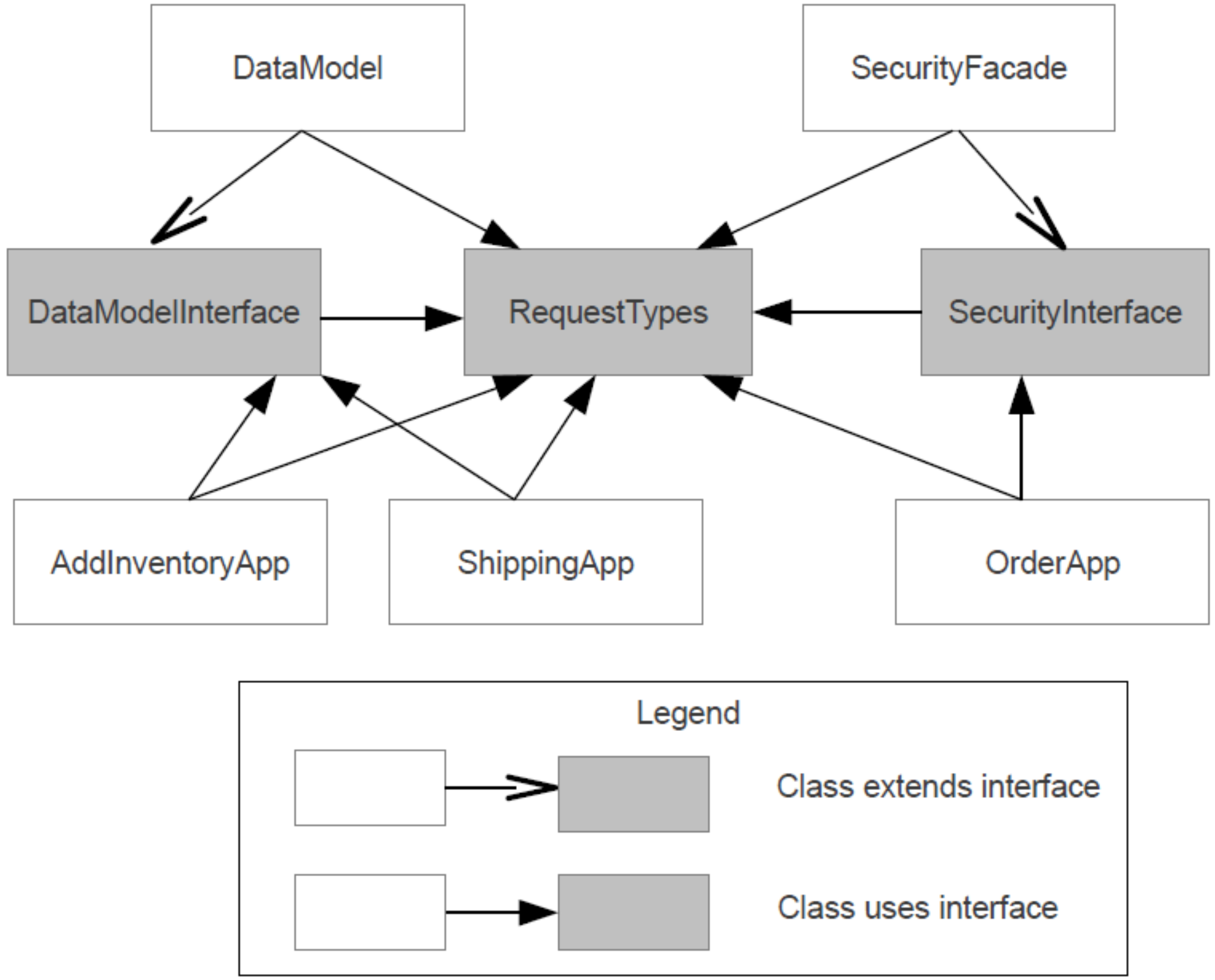
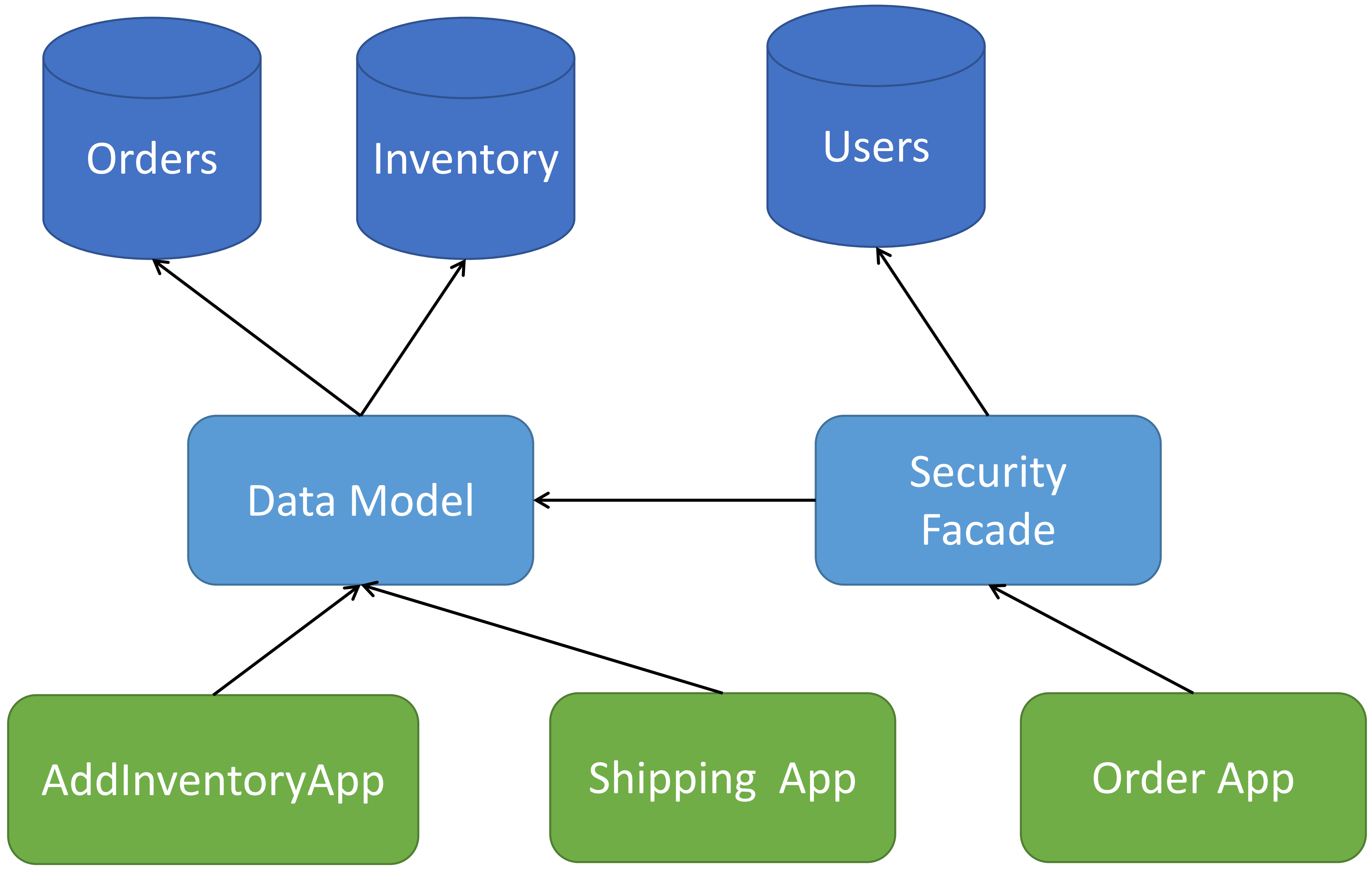
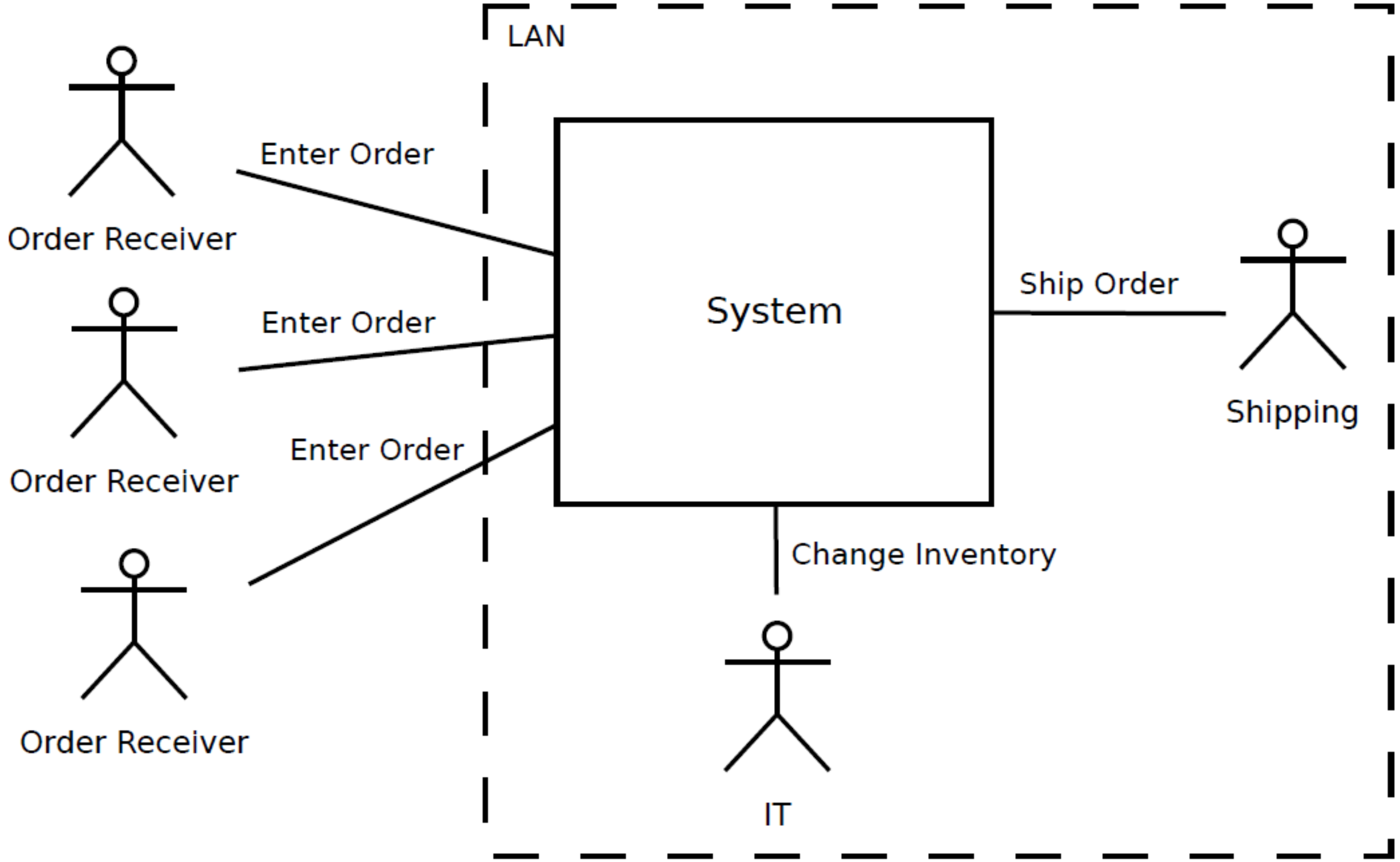
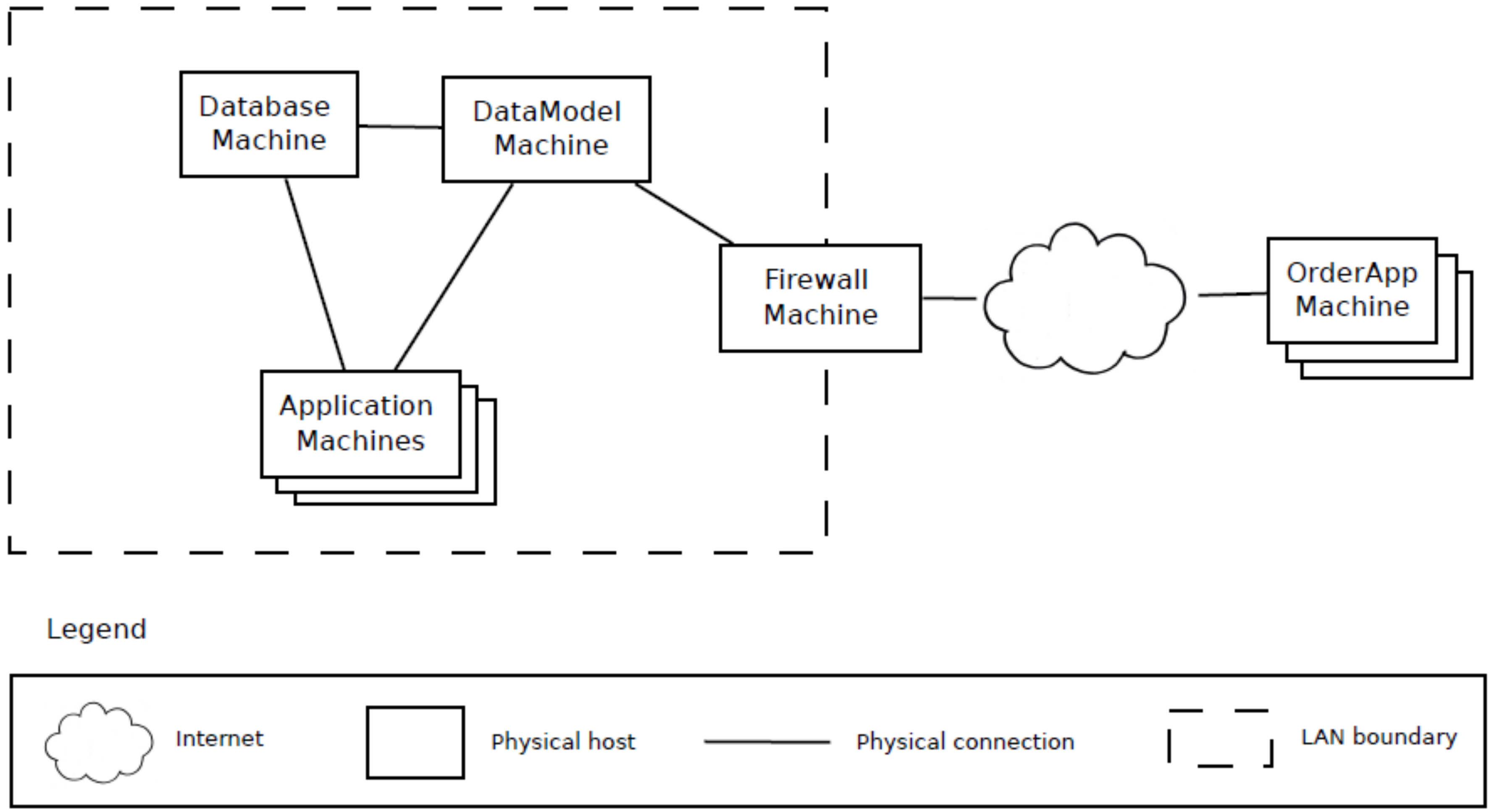
- **Allocation** (Physical, Deployment)

Mapping from software structures to the system’s organizational, developmental, installation, and execution environments.


DataModel
SecurityFacade
DataModelInterface
RequestTypes
SecurityInterface
AddInventoryApp
ShippingApp
OrderApp
Legend
Class extends interface
Class uses interface


Orders
Inventory
Users
Data Model
Security Facade
AddInventoryApp
Shipping App
Order App


LAN
Order Receiver
Enter Order
Order Receiver
Enter Order
Enter Order
Order Receiver
System
Ship Order
Shipping
Change Inventory
IT


Database Machine
DataModel Machine
Firewall Machine
Application Machines
OrderApp Machine
Legend
Internet
Physical host
Physical connection
LAN boundary

Selecting a Notation

- Suitable for purpose
- Often visual for compact representation
- Usually boxes and arrows
- UML possible (semi-formal), but possibly constraining
  - Note the different abstraction level – Subsystems or processes, not classes or objects
- Formal notations available
- Decompose diagrams hierarchically and in views

Guidelines: Avoiding Ambiguity

- Always include a legend
- Define precisely what the boxes mean
- Define precisely what the lines mean
- Supplement graphics with explanation
    - Very important: rationale (architectural intent)
- Do not try to do too much in one diagram
    - Each view of architecture should fit on a page
    - Use hierarchy

What could the arrow mean?

- Many possibilities
  - A passes control to B
  - A passes data to B
  - A gets a value from B
  - A streams data to B
  - A sends a message to B
  - A creates B
  - A occurs before B
  - B gets its electricity from A
  - …