OT2004 - TU1

Software Architecture Using Viewpoints and Perspectives

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Timetable

00:00 – 00:10	Introductions
00:10 – 00:40	Overview of viewpoints
00:40 – 00:50	Identify example systems
00:50 – 01:15	Ex1: identify viewpoints
01:15 – 01:30	Break
01:30 – 01:45	Overview of perspectives
01:45 – 02:15	Ex2: identify perspectives
02:15 – 02:30	Review and discussion

Introductions

Nick Rozanski

- Software architect
- IT/information systems/systems integration
- French Thornton

Eoin Woods

- Software architect
- information systems/Internet/system software
- Artechra (independent)

Introductions

Background

- Met at Sybase (1994 – 1999)
- Once asked "*what's the best architecture book?*" - we didn't have a good answer
- Subsequent research led us to
  - IEEE 1471
  - 4+1, Siemens, RM-ODP, Garland and Anthony
  - Our own viewpoint set
  - Definition of "perspectives" for qualities
  - Forthcoming book

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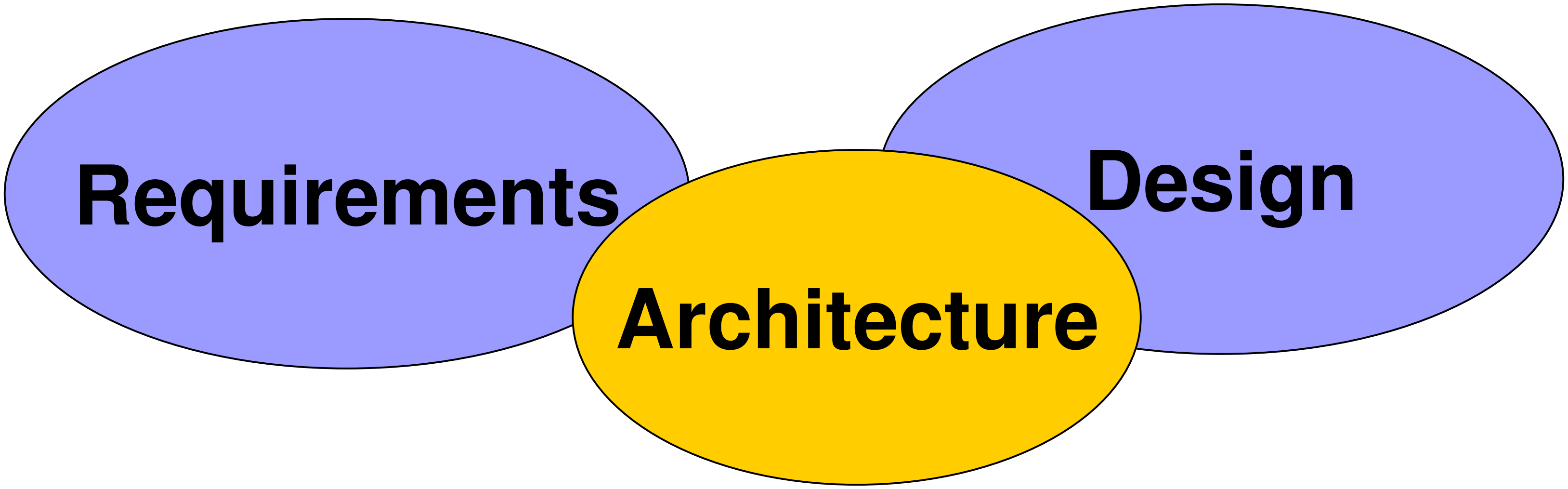
Software Architecture in Context

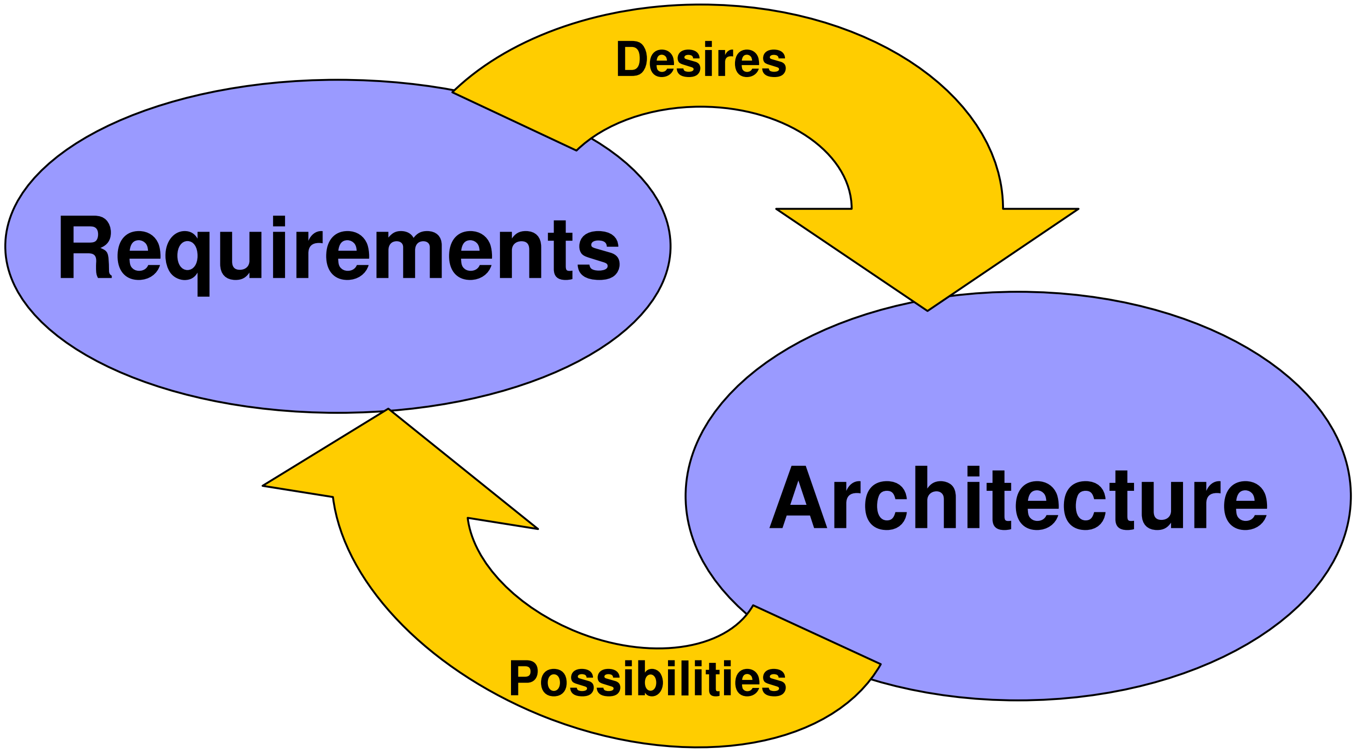


The crucial bridge between requirements and design

Software Architecture in Context

- Requirements frame the architectural problem
  - □ Stakeholder needs and desires
- Yet, architecture influences requirements
  - □ “The art of the possible”
  - □ Helps stakeholder understanding of risk/cost
  - □ Helps stakeholder understanding of possibilities

Architecture and Requirements



This interplay is core to the architectural process

Overview of Viewpoints

*The **software architecture** of a program or computing system is the **structure or structures of the system**, which comprise software **elements** the externally visible **properties** of those elements, and the **relationships** among them*

Bass, Clements and Kazman (SEI)

Software Architecture in Practice

Overview of Viewpoints

- Architecture is about defining structures – not one but many
  - □ Functional structure
  - □ Information structure
  - □ Concurrency structure
  - □ Design time structure
  - □ …

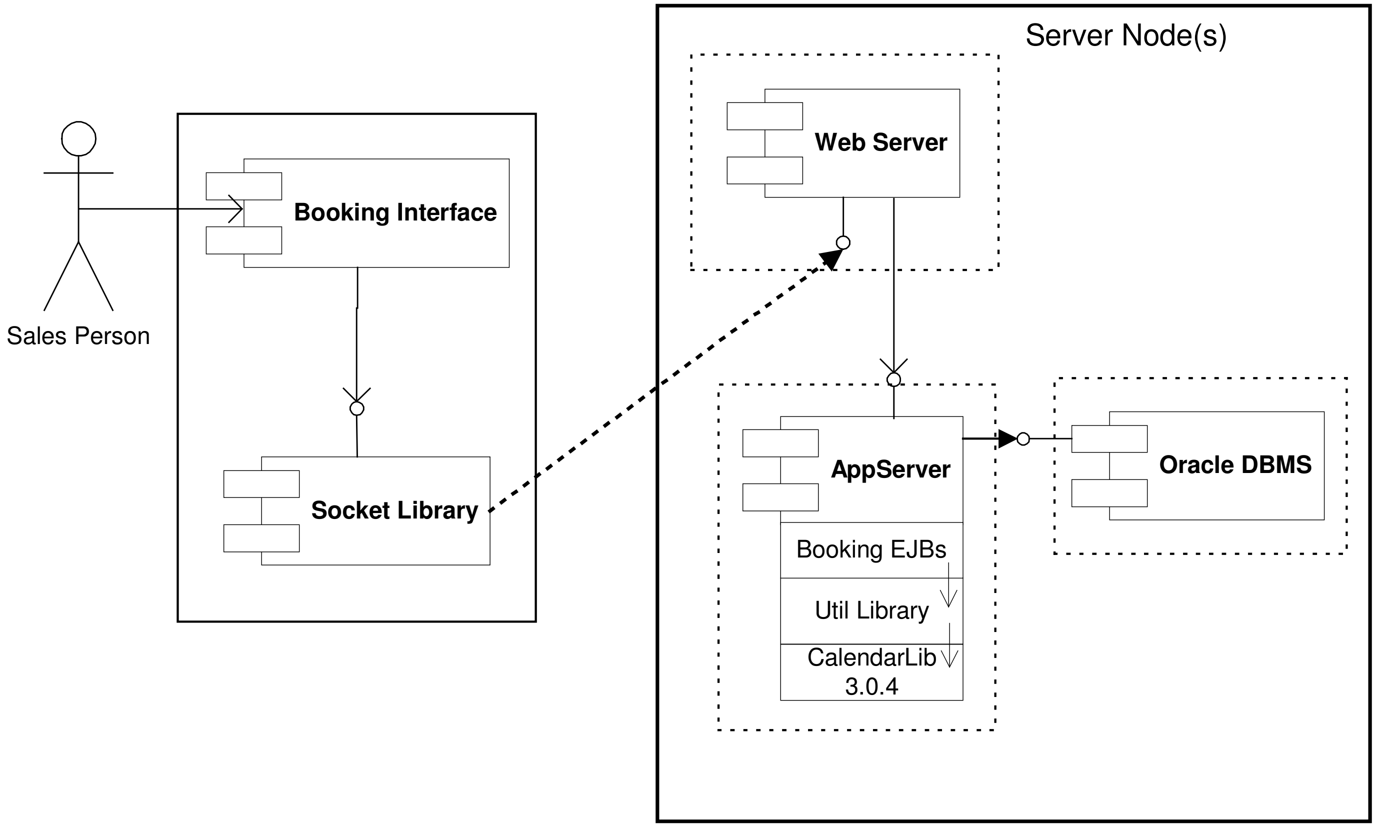
It's also very much about properties – we'll get to these later

Overview of Viewpoints

- Dealing with many structures is hard
  - Organization of ideas
  - Understanding different aspects simultaneously
  - Separating concerns
  - Dealing with different aspects equally
  - Consistency

Overview of Viewpoints

- Typical representation …



Overview of Viewpoints

- Architecture today is largely ad-hoc
  - Little standardisation in description
  - Difficult to compare and discuss alternatives
  - No process for developing architectures
- Need a conceptual framework to
  - Organise the architectural design process
  - Allow classification of ideas
  - Capture knowledge for discussion and reuse

Overview of Viewpoints

- Use views as the organising abstraction for the design and description

*A **view** is a **representation** of all or **part of an architecture**, from the perspective of one or more **concerns** which are held by one or more of its stakeholders.*

[IEEE Standard 1471 – Recommended Practice for Architectural Description]

Overview of Viewpoints

- Views are fine but …
  - Little more than a documentation convention
  - No help for structuring architectural knowledge or guidance
  - No guidance on process
  - Many common pitfalls for the unwary

We need another concept to work along with views

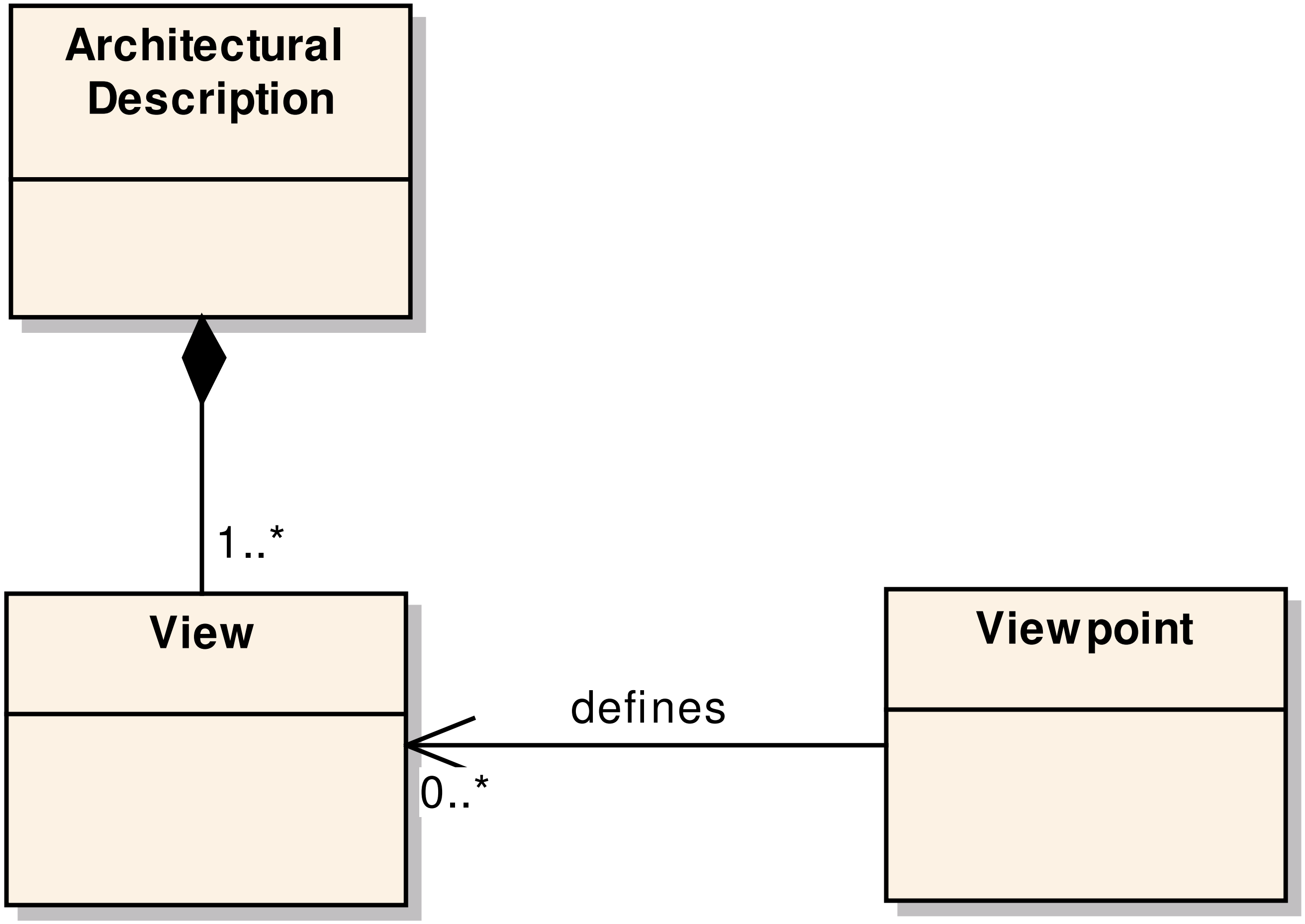
Overview of Viewpoints

- Use viewpoints as the organising abstraction for the process

> *A **viewpoint** is a collection of **patterns, templates and conventions** for **constructing** one **type of view**. It defines the **stakeholders** whose concerns are reflected in the viewpoint, and **guidelines** and **principles** and **template models** for constructing its views.*

[IEEE Standard 1471]

Primary Relationships



Rationale

- Viewpoints provide
  - A store of knowledge and experience
  - A guide to the architect
  - Templates to guide the process
- Views provide
  - A structure for description
  - A separation of concerns
  - Improved stakeholder communication

Overview of Viewpoints

- A number of people have suggested ways of using views for architecture
  - □ Phillippe Kruchten ("4+1", 1995)
  - □ Hofmeister, Nord, Soni ("Siemens Set", 1999)
  - □ RM-ODP (1995/96)
  - □ Jeff Garland and Richard Anthony (2003)

All slightly different ideas, leading to some confusion

Overview of Viewpoints

- IEEE Standard 1471-2000

  “IEEE Recommended Practice for Architectural Description”

  - □ Standardises the fundamental definitions for the approach
  - □ Rationale, context, content, etc.
  - □ Provides a meta-model so we can all talk about the same things

Overview of Viewpoints

- Viewpoints generally defined in sets
  - □ Philippe Kruchten (“4+1”)
    - Logical, Process, Development, Physical
  - □ Hofmeister, Nord and Soni
    - Conceptual, Module, Execution, Code
  - □ Rozanski and Woods
    - Evolution/specialisation of Krutchen’s “4+1” set
    - Functional, Information, Concurrency, Development, Deployment, Operational

Overview of Viewpoints

- Rozanski and Woods set
  - Aimed at modern, large scale, distributed information systems
  - Extension and refinement of Kruchten's set
    - Renamed & evolved "Logical", "Process" and "Physical"
    - "Information" and "Operational" added
  - Defined the contents of the viewpoints
    - Not just noted their existence

Overview of Viewpoints

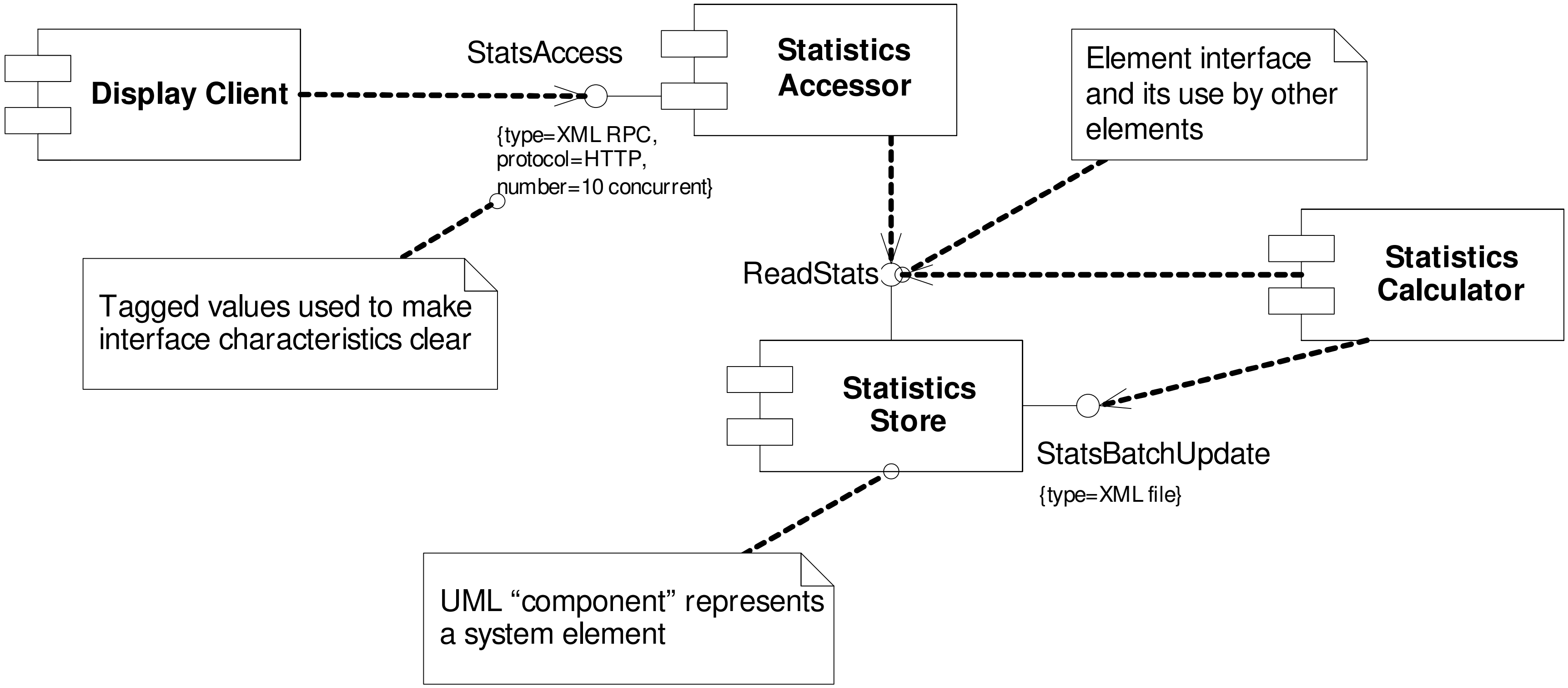
- Content of our viewpoints
  - Concerns
  - Applicability
  - Stakeholders
  - Models (content, notation, activities)
  - Pitfalls and how to avoid them

Overview of Viewpoints

- Functional
  - The functional structure of the system
    - Fundamental pieces (components, classes, procedures, systems, …)
    - Element, interface, interaction
  - Functional structure model
  - Concerns include
    - Functional coverage
    - Quality of functional structure

Overview of Viewpoints

- Functional – Example Content Fragment



Element interface and its use by other elements

Tagged values used to make interface characteristics clear

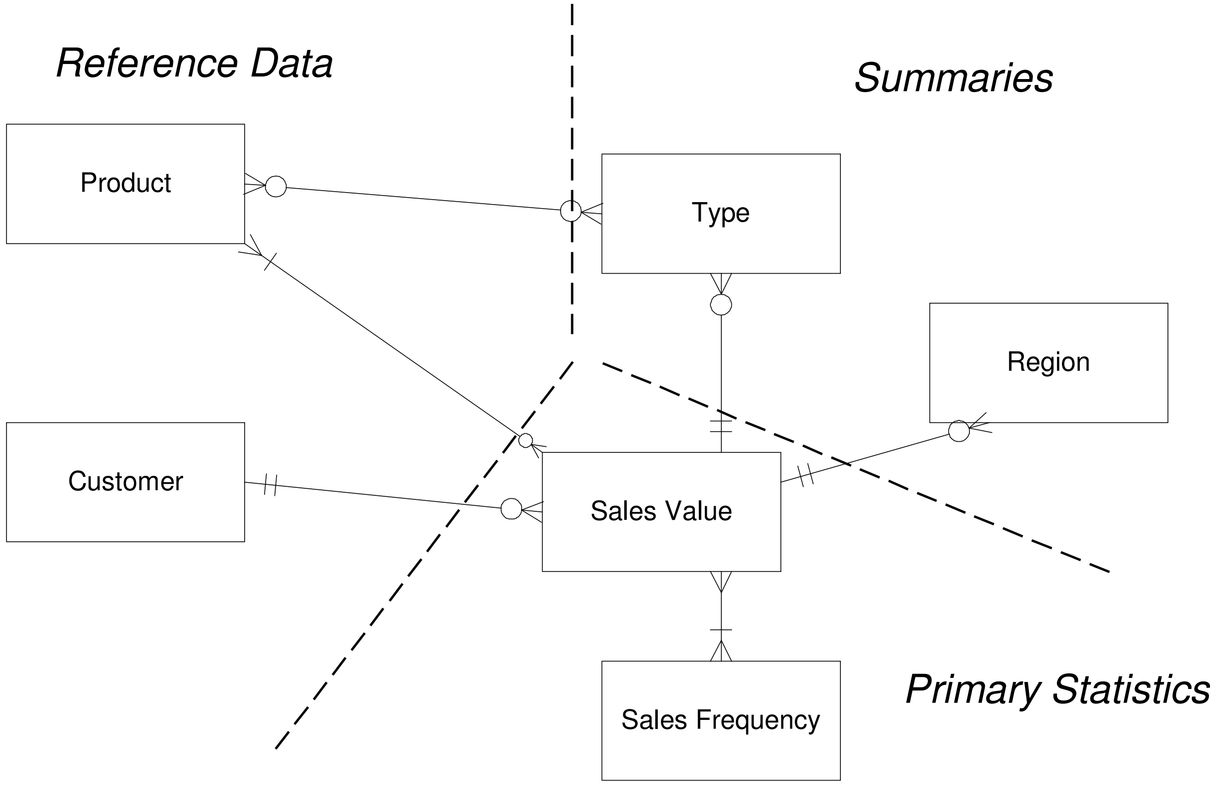
UML "component" represents a system element

Overview of Viewpoints

- Information
  - □ The information structure of the system
    - The information stored and how it is used
    - Entity/cluster, relationship, reference, owner, …
  - □ Augmented high-level data model
  - □ Concerns include
    - Information content and structure
    - Ownership and manipulation of information

Overview of Viewpoints

- Information – Example Content Fragment



Architectural static structure

Overview of Viewpoints

- Information – Example Content Fragment

	Data Warehouse	Statistics Calculator	Statistics Accessor
Primary Statistics	-	CRUD	R
Reference Data	CRUD	R	R
Summaries	RD	CRU	R

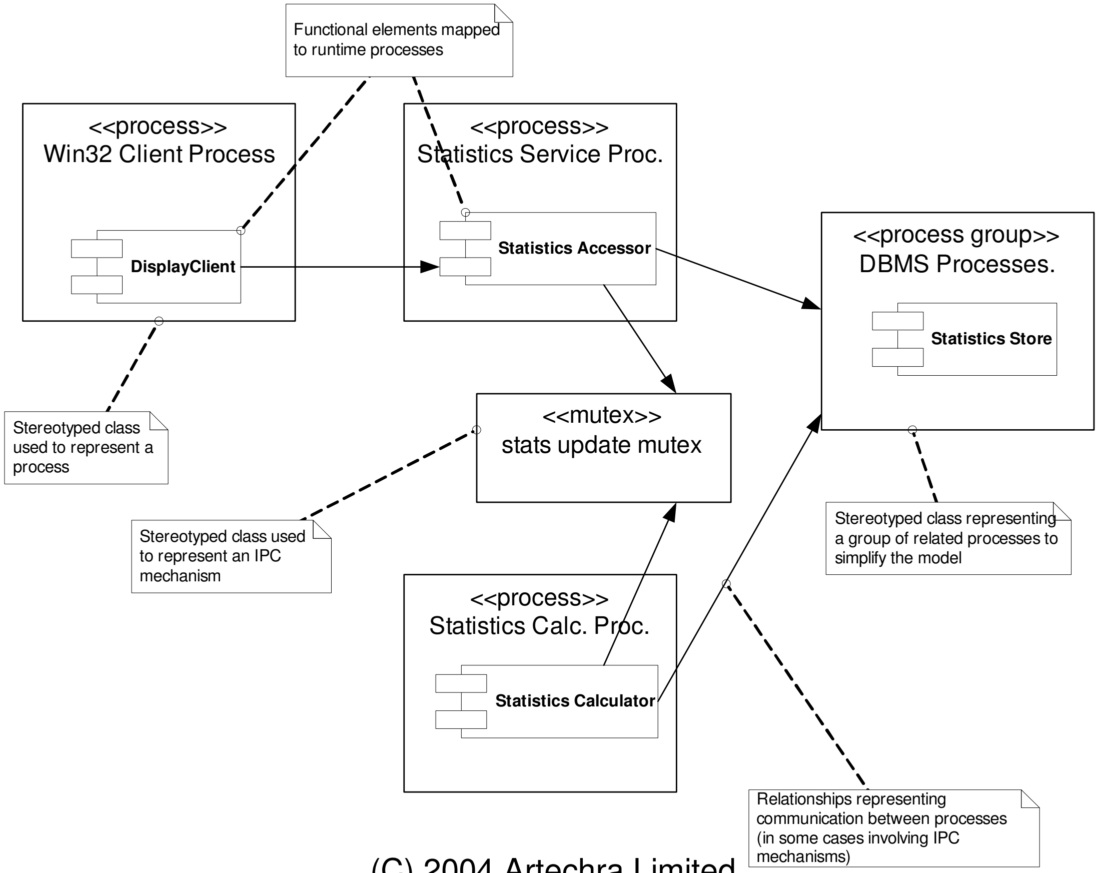
Data ownership model

Overview of Viewpoints

- Concurrency
  - The runtime structure of the system
    - Mapping elements to runtime elements
    - Process/thread, IPC, state
  - Task and coordination model
  - Concerns include
    - Placing elements in appropriate runtime elements
    - Integrity of runtime structure

Overview of Viewpoints

- Concurrency – Example Content Fragment

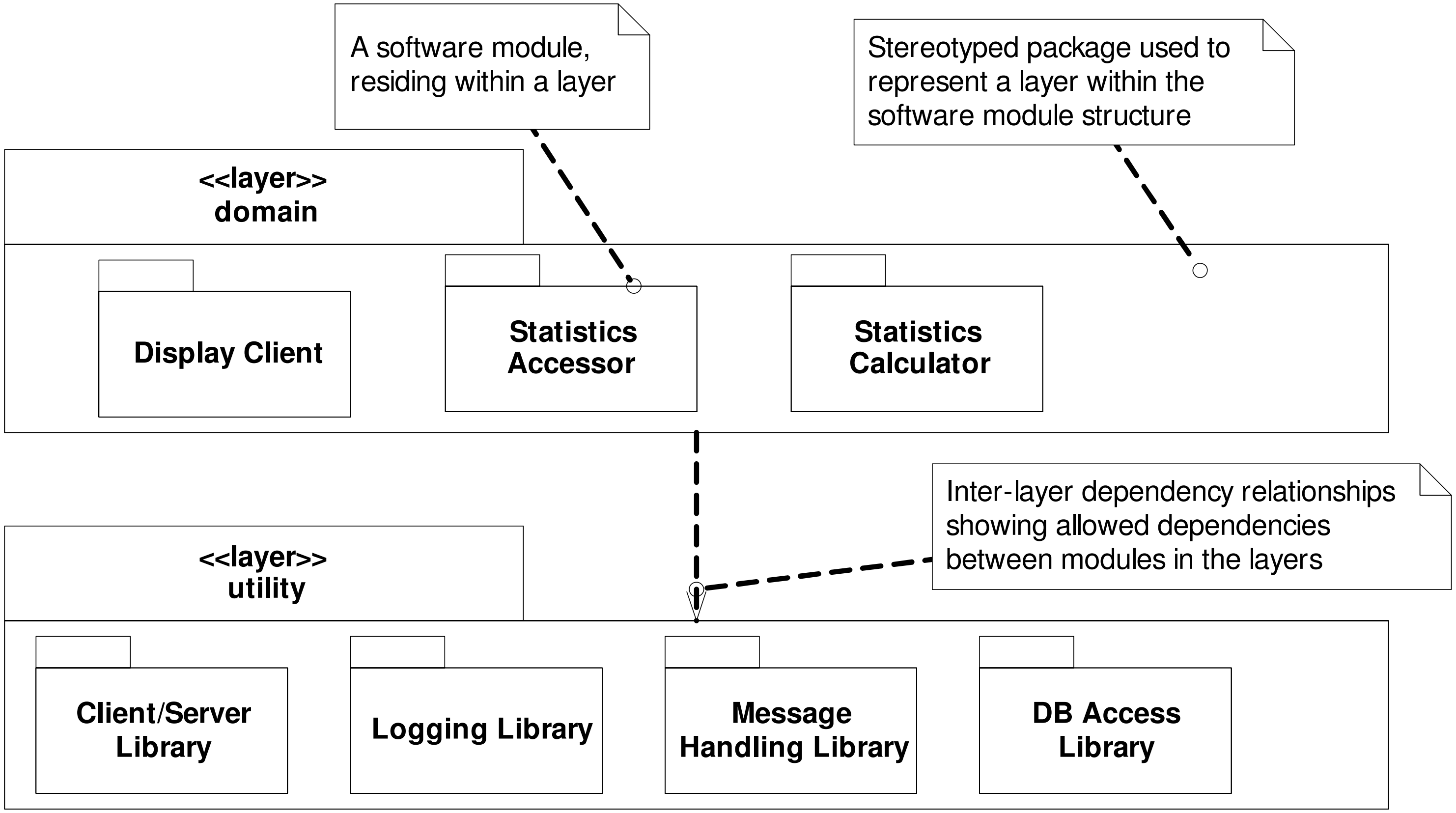

Functional elements mapped to runtime processes
<<process>>
Win32 Client Process
DisplayClient
<<process>>
Statistics Service Proc.
Statistics Accessor
<<process group>>
DBMS Processes.
Statistics Store
Stereotyped class used to represent a process
<<mutex>>
stats update mutex
Stereotyped class used to represent an IPC mechanism
Stereotyped class representing a group of related processes to simplify the model
<<process>>
Statistics Calc. Proc.
Statistics Calculator
Relationships representing communication between processes (in some cases involving IPC mechanisms)

Overview of Viewpoints

- Development
  - The architectural constraints on design/code
    - What must and must not be done
    - The shared development environment
  - Module structure, common design & codeline
  - Concerns include
    - Common processing and design style
    - Control of development environment

Overview of Viewpoints

- Development – Example Content Fragment

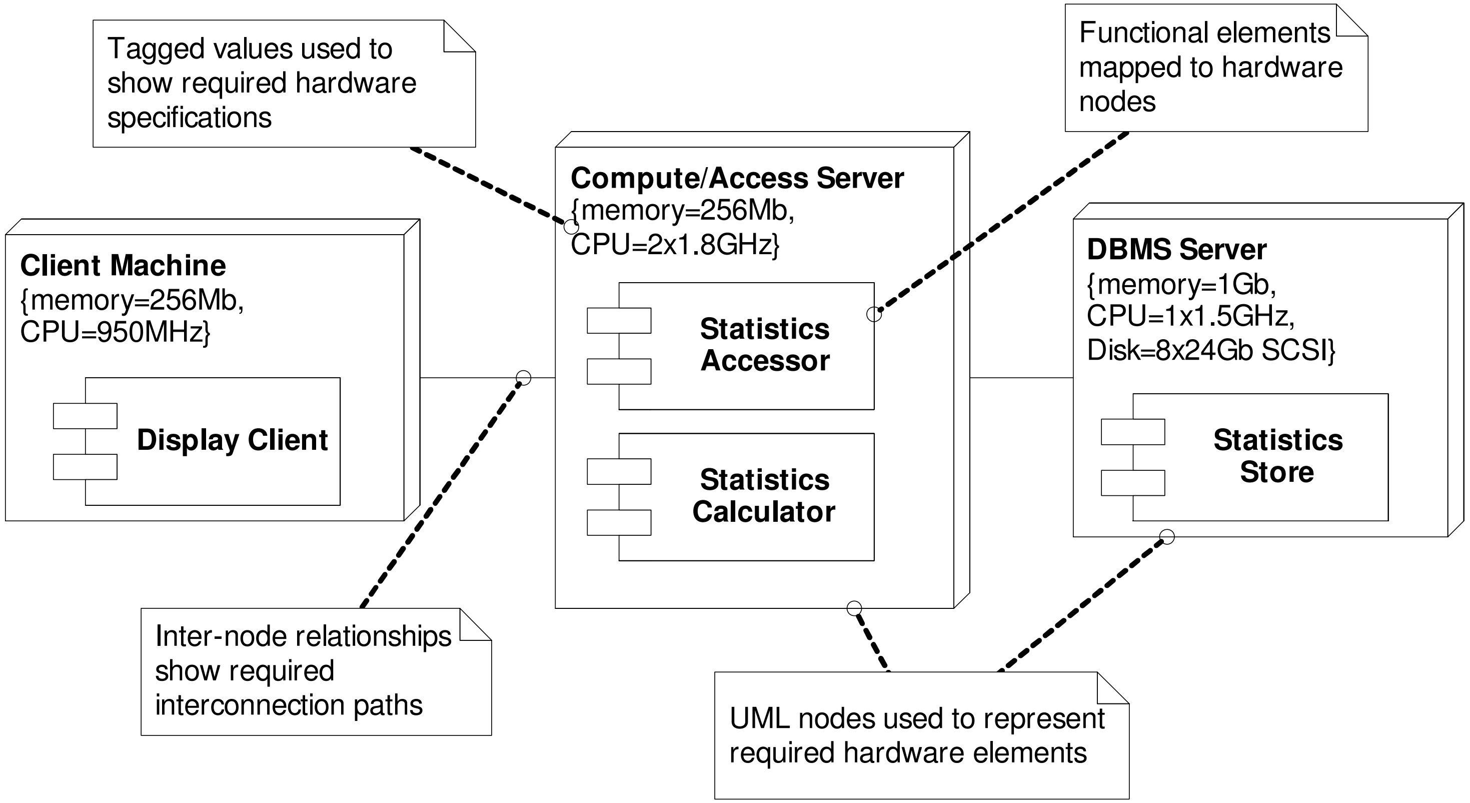

A software module, residing within a layer
Stereotyped package used to represent a layer within the software module structure
<<layer>>
domain
Display Client
Statistics Accessor
Statistics Calculator
Inter-layer dependency relationships showing allowed dependencies between modules in the layers
<<layer>>
utility
Client/Server Library
Logging Library
Message Handling Library
DB Access Library

Overview of Viewpoints

- Deployment
  - □ The production runtime environment
    - Identification of runtime platforms
    - Node, communication link, dependencies
  - □ Platform, network & dependency models
  - □ Concerns include
    - Platform capacity and specification
    - Network link capacity
    - Software stacks required on nodes

Overview of Viewpoints

- Deployment – Example Content Fragment


Tagged values used to show required hardware specifications
Functional elements mapped to hardware nodes
Compute/Access Server
{memory=256Mb, CPU=2x1.8GHz}
Statistics Accessor
Statistics Calculator
Client Machine
{memory=256Mb, CPU=950MHz}
Display Client
DBMS Server
{memory=1Gb, CPU=1x1.5GHz, Disk=8x24Gb SCSI}
Statistics Store
Inter-node relationships show required interconnection paths
UML nodes used to represent required hardware elements

Overview of Viewpoints

- Operational
  - The structures required around the system
    - Getting into production, staying reliable there
    - Install elements, tools, dependencies, ...
  - Install, migration, CM, admin, support models
  - Concerns include
    - Installation, migration and backout
    - Effective monitoring and control
    - Recognising and responding to problems

Overview of Viewpoints

- Operational – Example Content Fragment
  - Installation, migration and backout strategies
  - Monitoring and Control strategies
  - Operational configuration management
  - Support model (who is responsible for what, escalation)
- All at the architecture, not detail level (constraints & strategies, not procedures)
- Not possible to show a lot here (space)

Overview of Viewpoints

- Administration of the Statistics Reporting System
  - ***Monitoring and Control***
    - *Server Message Logging*: All server components will write information, warning and error messages to the Windows Event Log.
    - *Client Message Logging*: The client software will log messages if an unexpected error is encountered. The log will be written to the hard disk of the client.
  - ***Operational Procedures***
    - *Backup*: Data in the database will need backed up. This will involve […]
    - […]
  - ***Error Conditions***
    - *Database Out of Log Space*: If transaction volume rises above a certain point then it is possible that the transaction log will fill. This will […]
    - […]
  - ***Performance Monitoring***
    - *Database Counters*: The following performance counters can be […]
    - […]

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01:45 – 02:15	Ex2: identify perspectives
02:15 – 02:30	Review and discussion

Exercise Preparation

- Each group needs a system to discuss
  - Break into groups
  - 5 – 10 minutes, choose a system one of you has worked on
  - You will use this system as the example during the exercises
  - Ideally a mid-size distributed information system, but this isn’t crucial
  - Explain the system to your group

Exercise Preparation

- For your system capture
  - Context diagram
  - Outline functional description
  - Key quality requirements
    - Security, performance, availability, …
  - Main functional elements and interfaces
  - Anything else “unusual”

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Exercise 1: Identify Viewpoints

- For your example system
  - Identify the views that are most important to describe it
  - Using the VP definitions as a guide, sketch views for your system on flipcharts
  - Identify any missing aspect to the description
    - Where does this go?
    - Identify any views that you think are missing

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Break

- 15 minutes

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Overview of Perspectives

- Think back to exercise 1
- What were you doing to identify structures?
  - What the system had to do
  - How system had to do it
- The “how” is referred to as the “quality properties” of the system

Overview of Perspectives

- Quality properties are the non-functional characteristics of the system ("-illities")
  - □ Performance
  - □ Efficiency
  - □ Security
  - □ Maintainability
  - □ Availability
  - □ …

Overview of Perspectives

- Quality properties crucial to stakeholders
  - Slow functions don’t get used
  - Unavailable systems cause business interruption
  - Security problems cause headlines
  - Unmaintainable systems become irrelevant

Yet viewpoints don’t help at all with QPs!

Overview of Perspectives

- QPs are often an afterthought
  - Often expensive to “retro-fit”
  - Disruption to existing operations
  - May conflict with existing QPs
- Addressing QPs is key architectural task
  - Understanding stakeholder “real” needs
  - Trading off between conflicting needs
- Need a framework for thinking about QPs

Overview of Perspectives

- Use *perspectives* as the abstraction for dealing with quality properties

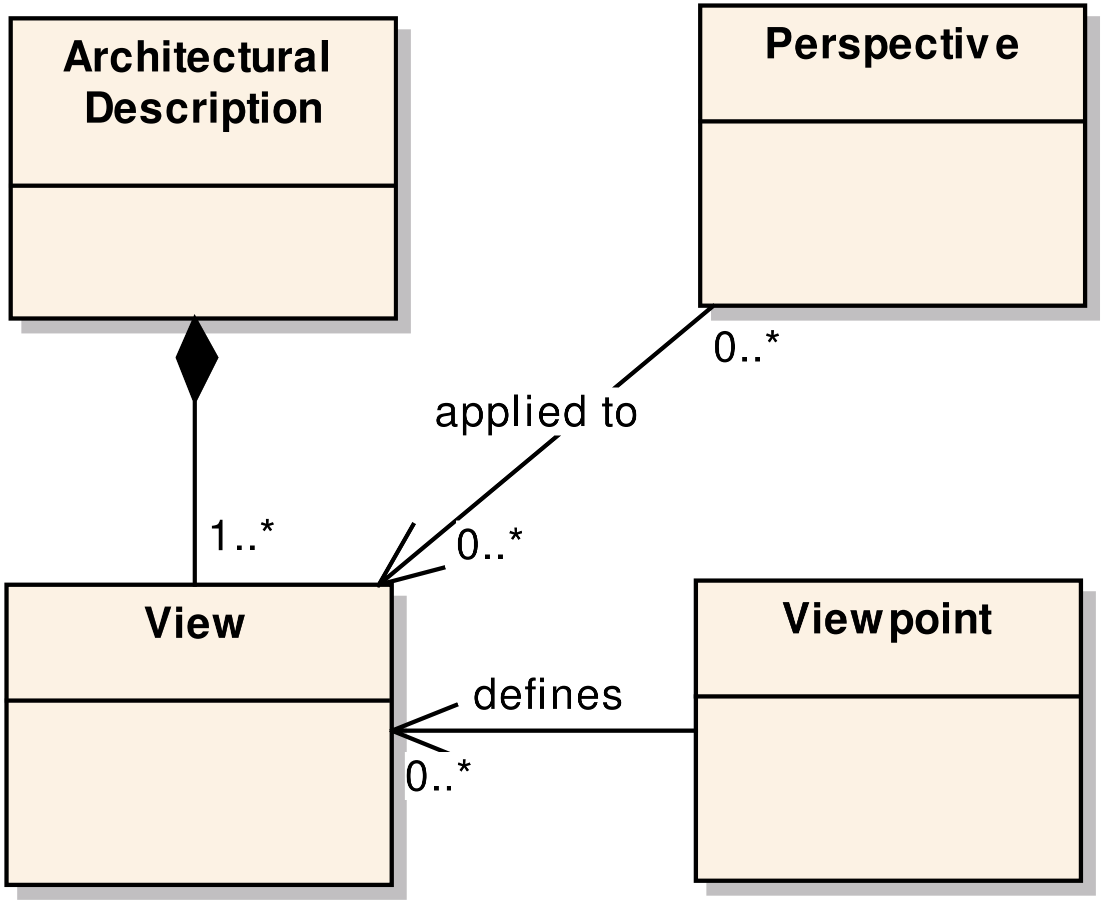
> *An architectural **perspective** is a collection of **patterns, templates and guidelines** to guide the process of ensuring that a **system exhibits** a particular set of closely related **quality properties** that require consideration across a number of the system's views.*

[Rozanski & Woods]

Overview of Perspectives

- A simple idea, but captures the key ideas
  - □ A store of knowledge and experience
  - □ A guide to the architect
  - □ Templates to guide the process
- Analogous to viewpoints but for QPs
- You *apply* perspectives to the architecture to ensure QPs are acceptable and guide its development

Overview of Perspectives



Overview of Perspectives

- Our initial core set
  - □ Performance and Scalability
  - □ Security
  - □ Availability and Resilience
  - □ Evolution
  - □ Also: Location, I18N, Usability, Regulation, …

These will be different for different domains

Overview of Perspectives

- Content of our perspectives
  - Desired qualities
  - Applicability
  - Concerns
  - Activities
  - Architectural strategies
  - Pitfalls and how to avoid them

Overview of Perspectives

- Performance and Scalability
  - *Concerns*: processing volume, response time, responsiveness, throughput, predictability
  - *Techniques*: performance requirements definition, performance modelling, workload characterisation

Overview of Perspectives

- Security
  - □ *Concerns*: authentication, authorisation, confidentiality, integrity, accountability, availability, intrusion detection, recovery
  - □ *Techniques*: threat identification, threat assessment, vulnerability analysis, application of security technology

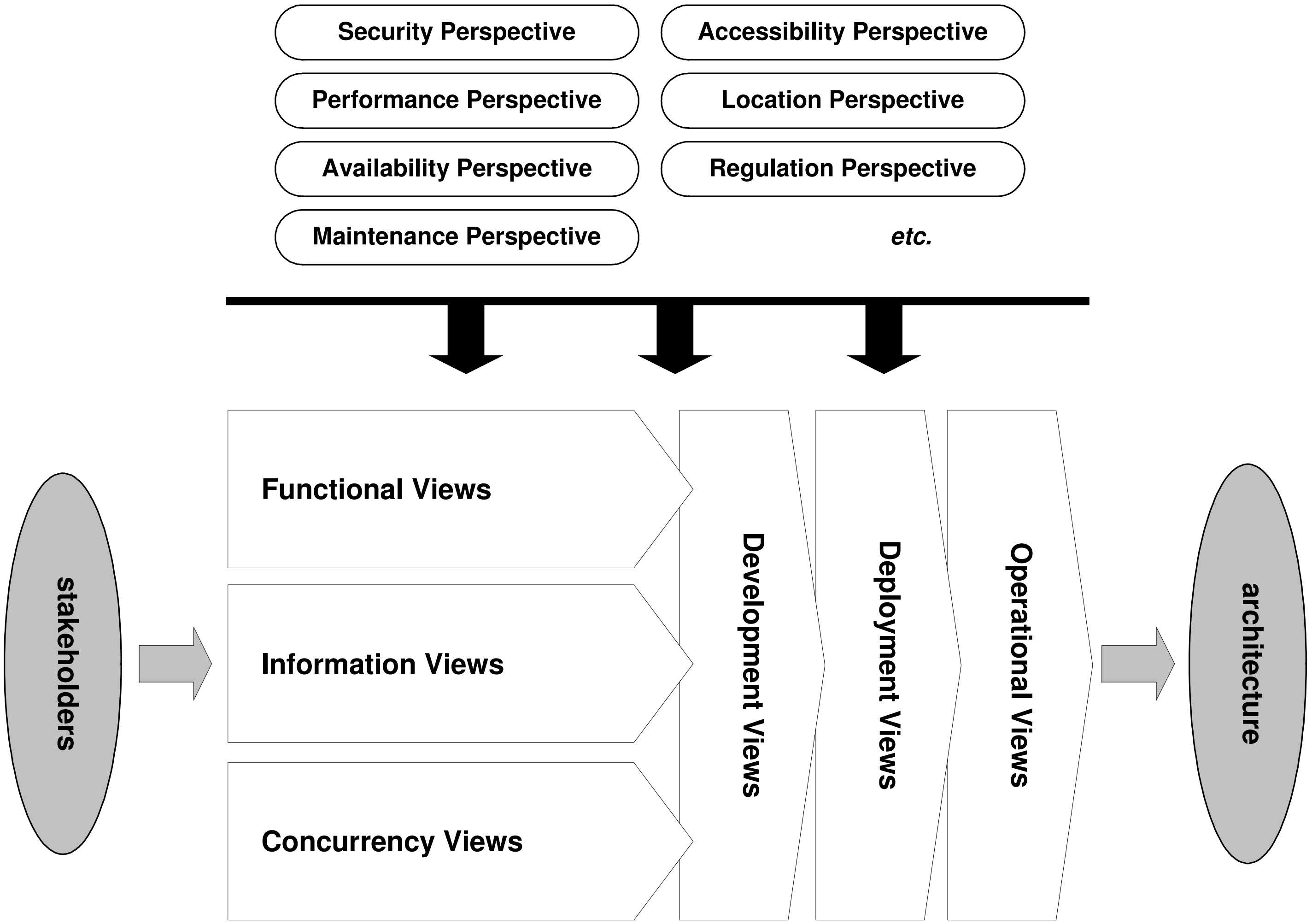
Overview of Perspectives

- Availability and Resilience
  - □ *Concerns*: classes of service, planned / unplanned downtime, mean time between failures, mean time to repair, disaster recovery, redundancy, clustering, failover
  - □ *Techniques*: MTBF and MTTR prediction, availability schedules, availability models, availability technology application

Overview of Perspectives

- Evolution
  - *Concerns*: flexibility, extensibility, functional evolution, deployment evolution, integration evolution
  - *Techniques*: design for change, architectural assessment, configuration management, automated testing, build and release management

Overview of Perspectives



Security Perspective

Performance Perspective

Availability Perspective

Maintenance Perspective

Accessibility Perspective

Location Perspective

Regulation Perspective

etc.

stakeholders

Functional Views

Information Views

Concurrency Views

Development Views

Deployment Views

Operational Views

architecture

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Exercise 2: Identify Perspectives

- For your example system
  - □ Identify the perspectives that are most important to consider for it
  - □ Using the perspective definitions as a guide, sketch views the affect of applying them
  - □ Identify any missing QP considerations
    - Where are they addressed?
    - Identify any perspectives that you think are missing

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Review and Discussion

- Do we all have the same VP and P sets?
  - Why / why not?
- What VPs and Ps still need to be defined?
- How effective are VPs?
- How effective are Ps?
- What is missing/could be improved?

Review and Discussion

Thanks for coming to the session, we hope you found it useful and interesting.

Let us know how you get on with viewpoints and perspectives.