The Past, Present and Future of Software Architecture

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About me

- I'm a working software architect
  - Enterprise and software architecture
- Always worked as a software engineer
  - 8 years of products, 7 of applications
- Recently moved to end-user company
  - Stream architect in ETD area
  - Major re-engineering effort
- Co-author of software architecture book
  - With Nick Rozanski, Addison-Wesley, 2005
- Participant in IFIP 2.10 WG

Topics

- **Introducing Software Architecture**
- The Past
- The Present
- The Future

What Is Software Architecture

- *The software architecture of a program or computing system is the structure or **structures** of the system, which comprise software **elements**, the externally visible **qualities** of those elements, and the **relationships** among them*
  - Bass, Clements, Kazman (SEI)
    Software Architecture in Practice

What is Software Architecture

- *The set of **design decisions** which, if **made incorrectly**, will cause your project to be **cancelled***
  - Eoin Woods *(heads the SEI definitions list!)*

The SEI definitions list:
`www.sei.cmu.edu/architecture/definitions.html`

Just Design, Surely?

- All architecture is design, not all design is architecture [Paul Clements]
- Not all design decisions are equal
  - some have "*architectural significance*"
- Architectural design is outward looking
  - focus on stakeholder needs, not pure technology
- Architecture more fluid than design
  - context, scope, success criteria all unclear

Just Design, Surely?

- Architecturally Significant
  - concern, problem, system element; having
  - wide impact on structure of the system; or
  - wide impact on an important quality property (performance, availability, …)

(Philippe Kruchten, Intro to RUP, 2nd Edition, 2000)

Just Design, Surely?

Architecture	Global	Intentional
Design	Local	Intentional
Implementation	Local	Extensional

"*Architecture, Design, Implementation*",
Amnon Eden And Rick Kazman, ICSE 2003
`http://eden-study.org/articles/2003/icse03.pdf`

Is It Really "Architecture" ?

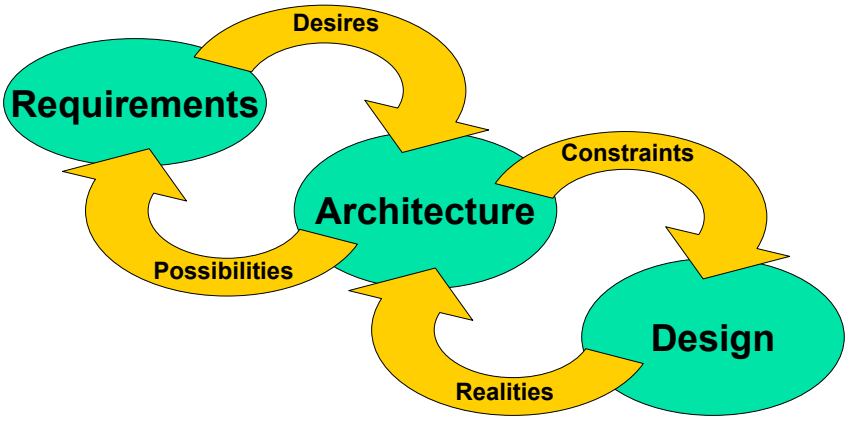
	Civil Architect	***Software Architect***
Training	Arts based	Engineering based
Focus	Aesthetics, usability	How it works
Key Responsibility	Vision, coordination	Delivery of solution
Key Talent	Feel for client need	Technical design

- But some similarities, both:
  - need a "big picture" focus and awareness
  - act as a bridge from customer to builder
- Software architect = civil architect + structural engineer?
- Don't push the analogies too far!

The Essence

- Software architecture is concerned with:
  - ***Stakeholders***
  - System-Level ***Structures***
  - System ***Qualities***
- Software architecture involves:
  - ***Understanding*** domains, problems and solutions
  - ***Making*** design ***decisions*** & tradeoffs
  - ***Delivering*** working systems

Architecture in Context

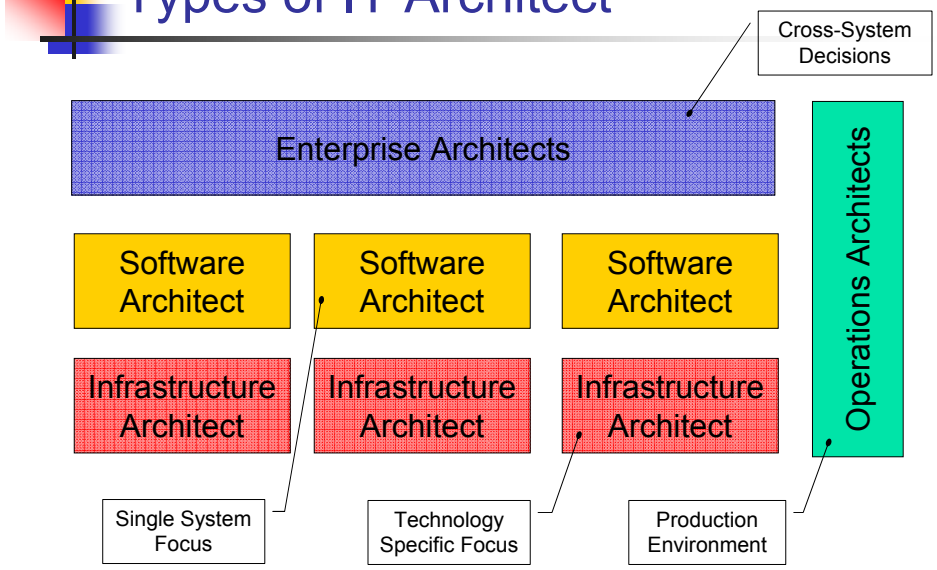


The crucial bridge between requirements and design
"Three Peaks" model – after Bashar Nuseibeh

Why Architecture is Important

- Stakeholder focus
  - who cares and why
  - more than just users and sponsors
- Ensuring that the right system is built
  - critical functions, crucial qualities
- System-wide (or cross-system) consistency
  - what should be constant, what should vary
- Early identification of risk
  - what is going to go wrong and how to avoid it

Types of IT Architect



Topics

- Introducing Software Architecture
- **The Past**
- The Present
- The Future

Where Did it Come From?

- Dates from mid-1980
  - roots as far back as late 1960s
  - mainstream interest from mid-1990s
- Began largely as an academic interest
  - from studying how systems were built
- Enthusiastically transferred into industry
  - little interchange between the two since!
- Mirrors the rise in importance and status of the technical IT professional

The Past - People

- 1985 – David Parnas and modules
  - 1987 – Zachman Framework
- 1992 – Dwayne Perry and Alex Wolf
- 1994 - Witt/Baker/Merritt book (IBM FSD)
- 1995 – Philippe Kruchten and 4+1
- 1996 – Shaw and Garlan's book
- 1998 – Bass, Clements, Kazman book
- 2000 – Team produce IEEE 1471
- 2003 – Martin Fowler admits it exists!

The Past - Process

- Constant arguments over “what is architecture”
- No shared understanding of what to do & when
- Pioneering architects ploughed ahead
  - Brooks (of course) – S/360
  - Witt/Baker/Merritt – IBM FSD
  - Kruchten - CATS
  - Cutler – Windows NT
  - Booch – methods and analysis
  - Shaw/Garlan/Bass/Kazman/Clements/Obink/ Ran/Muller/… – research and study

The Past - Technology

- Some hopeful technologies never took hold
  - ADLs
- Formalisms have been and gone
  - numerous architectural calculi
- Architects largely imposed architecture on resisting technology
  - components of COBOL !
- Little or no architectural thinking in many product lifecycles
  - ad-hoc structure and extension
  - little support for architectural practice

The Past - Politics

- Constantly answering the question "*what is a software architect and why do I need one?*"
- Early architects often had no recognition of role
  - constant explanation and education
- Little understanding of the benefits in most organisations
  - and conversely, limitations

Topics

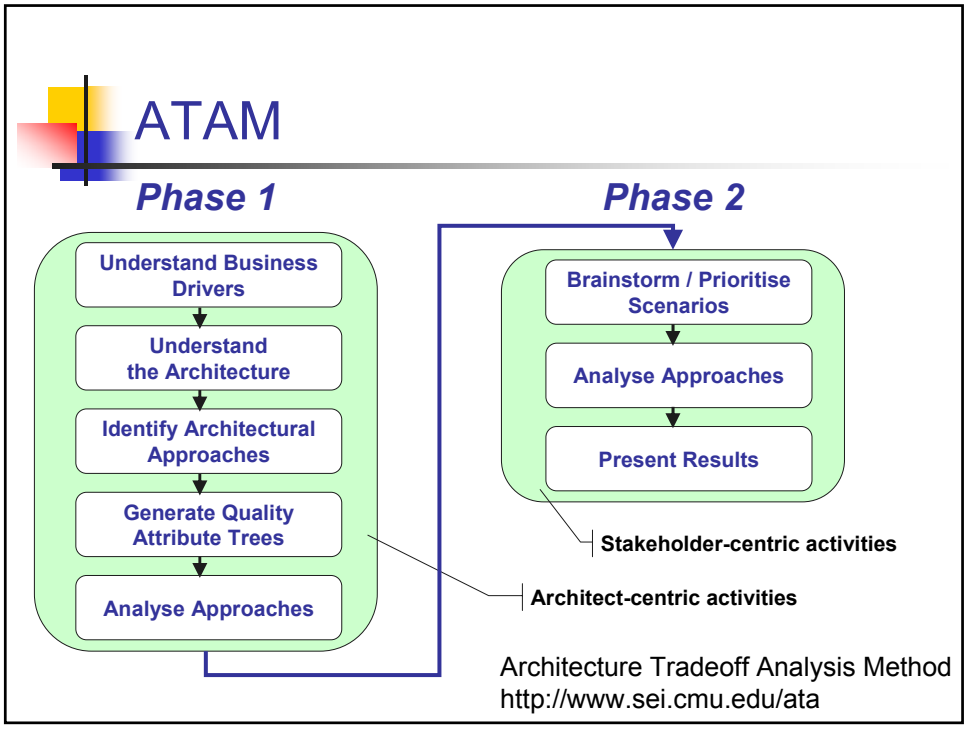
- Introducing Software Architecture
- The Past
- **The Present**
- The Future

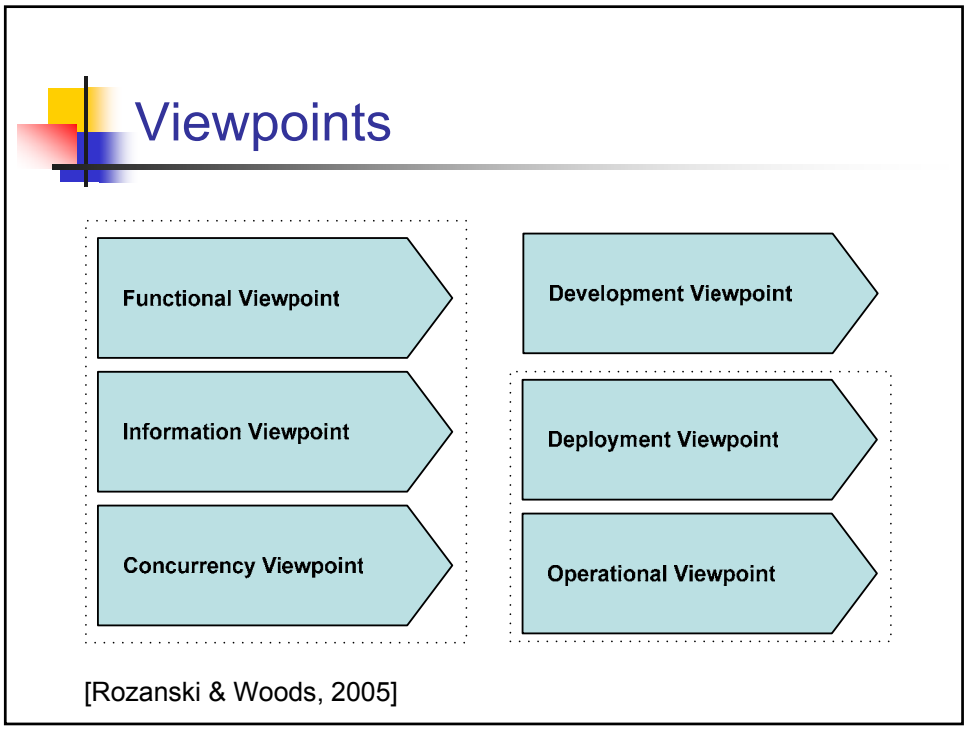
The Present - People

- Today architects have some industry support
  - Organisations like IASA, conferences like WICSA
- Organisations are seeing value
  - IBM, Microsoft, Hartford Financial, UBS, BP, …
- Some technology independent training
  - SEI, Open Group, various degree modules
- “Architect” appears in career frameworks
- But no clear route to architect jobs
  - Software developers, BAs, PMs, hybrid paths
  - Reflects confusion over nature of the role

The Present - Process

- Small number of reliable techniques
  - Viewpoints & views, ATAM, perspectives
- Focus on simple techniques to organise
  - Boxes and lines in PPT do tend to dominate!
  - Little real analysis of descriptions is possible
- Overall process is quite ad-hoc
- Little or no domain focus in approaches
- Reasonably large set of (basic) books
- Some standard terminology exists (e.g. 1471)
  - but not widely used


ATAM
Phase 1
Phase 2
Understand Business Drivers
Understand the Architecture
Identify Architectural Approaches
Generate Quality Attribute Trees
Analyse Approaches
Brainstorm / Prioritise Scenarios
Analyse Approaches
Present Results
Stakeholder-centric activities
Architect-centric activities
Architecture Tradeoff Analysis Method
http://www.sei.cmu.edu/ata


Viewpoints
Functional Viewpoint
Information Viewpoint
Concurrency Viewpoint
Development Viewpoint
Deployment Viewpoint
Operational Viewpoint
[Rozanski & Woods, 2005]

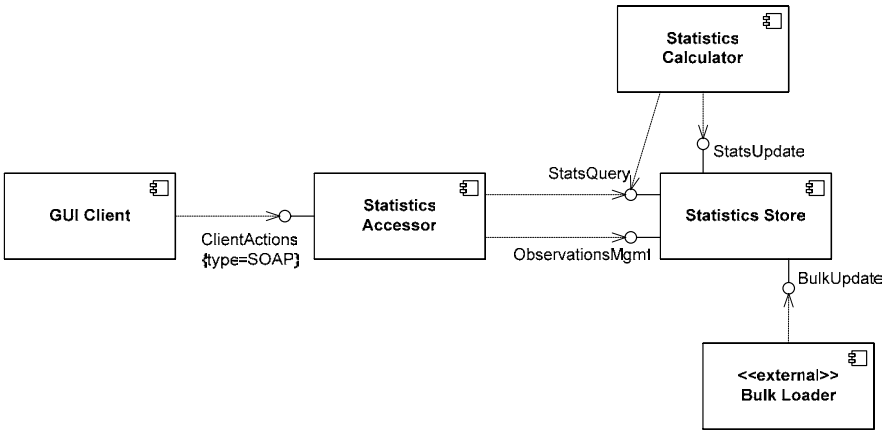
Viewpoints Example

- A statistics management system
  - Data bulk-loaded into the database
  - Derived measures calculated automatically
  - Statisticians view and report on the data
  - Deductions recorded and reviewed manually

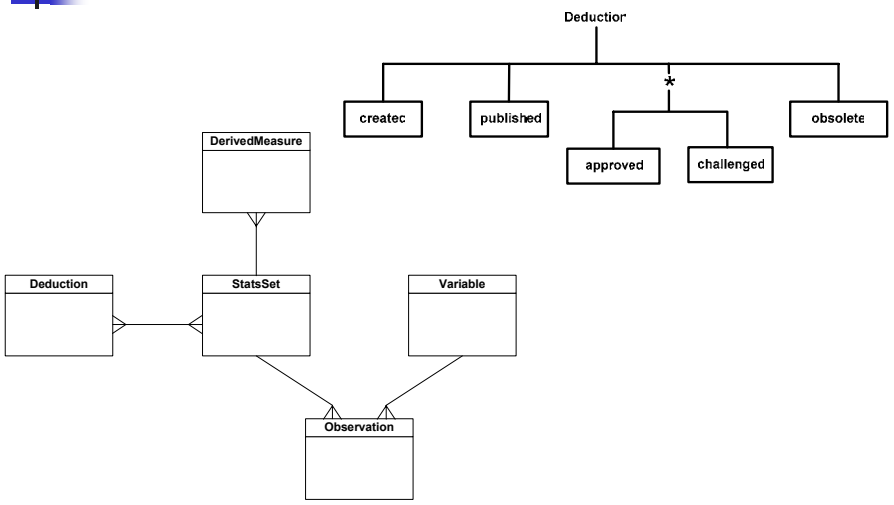
Viewpoints Example

- Described through 5 views
  - Functional
  - Information
  - Concurrency
  - Development
  - Deployment
  - *(Operational view omitted)*

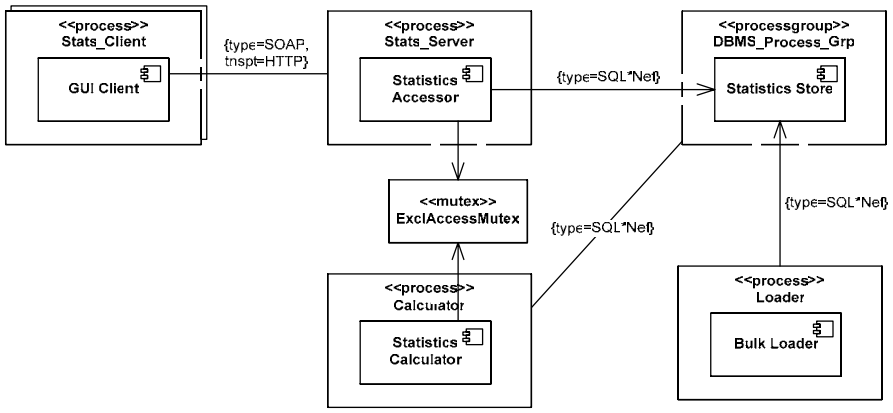
Functional View



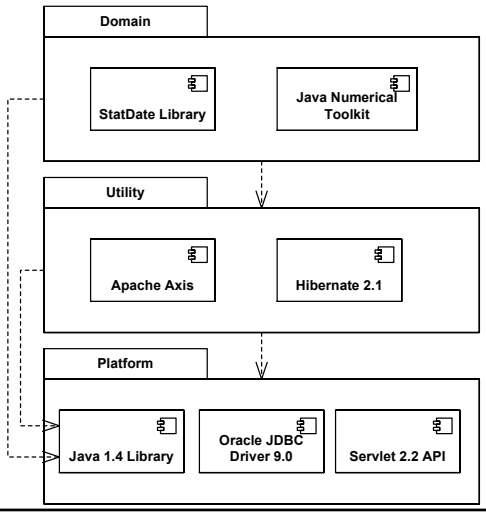
Information View



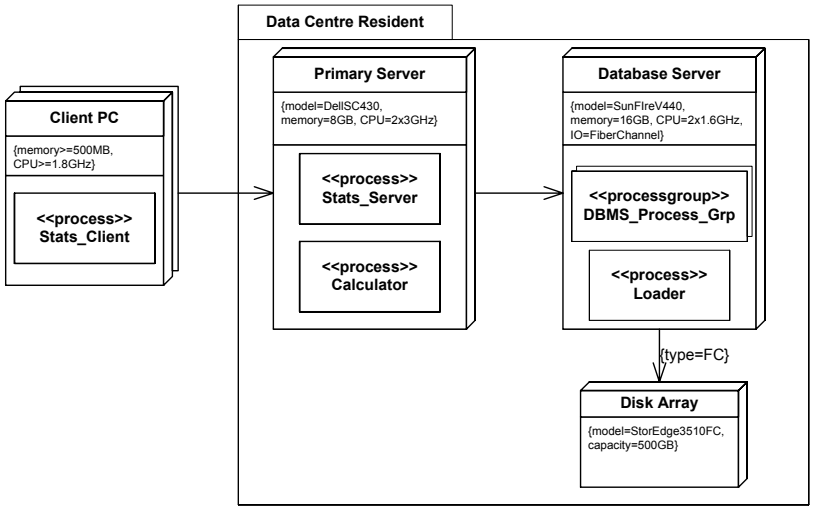
Concurrency View



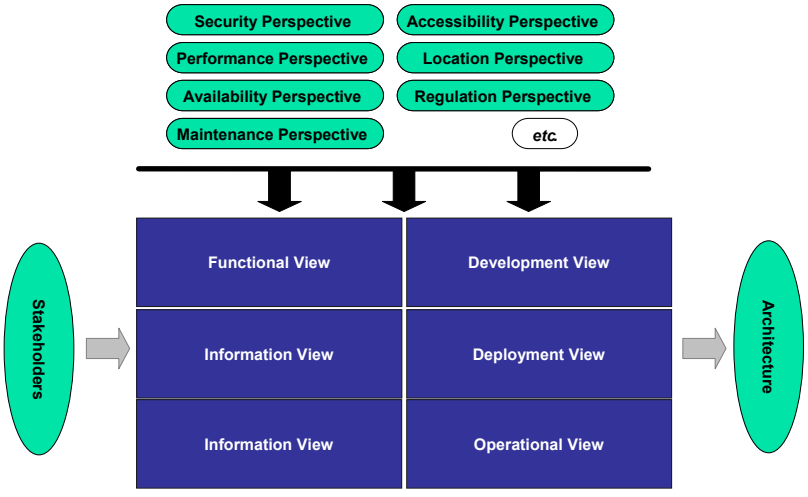
Development View



Deployment View



Viewpoints and Perspectives

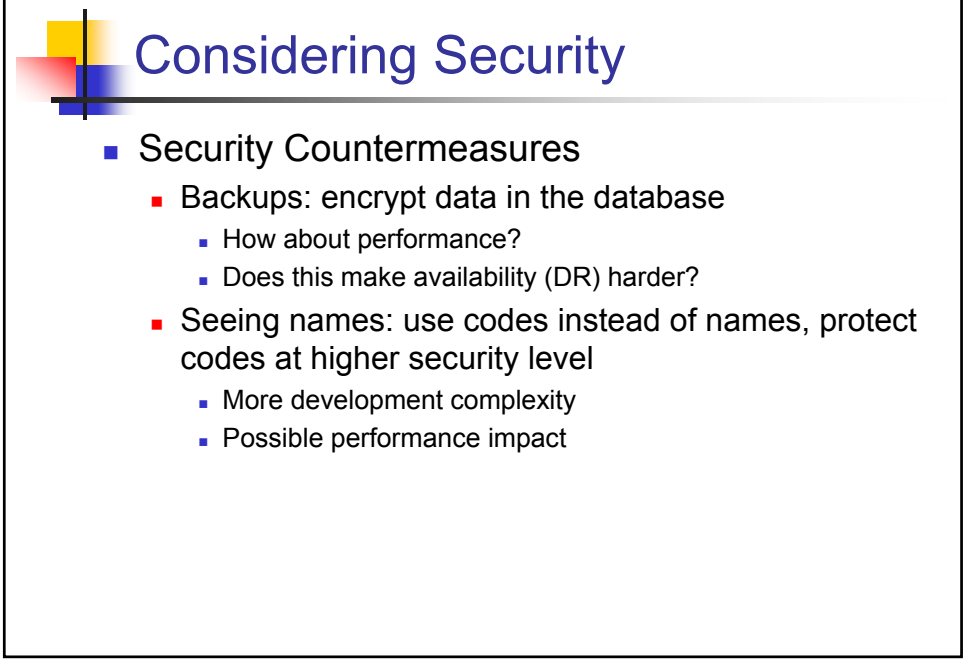


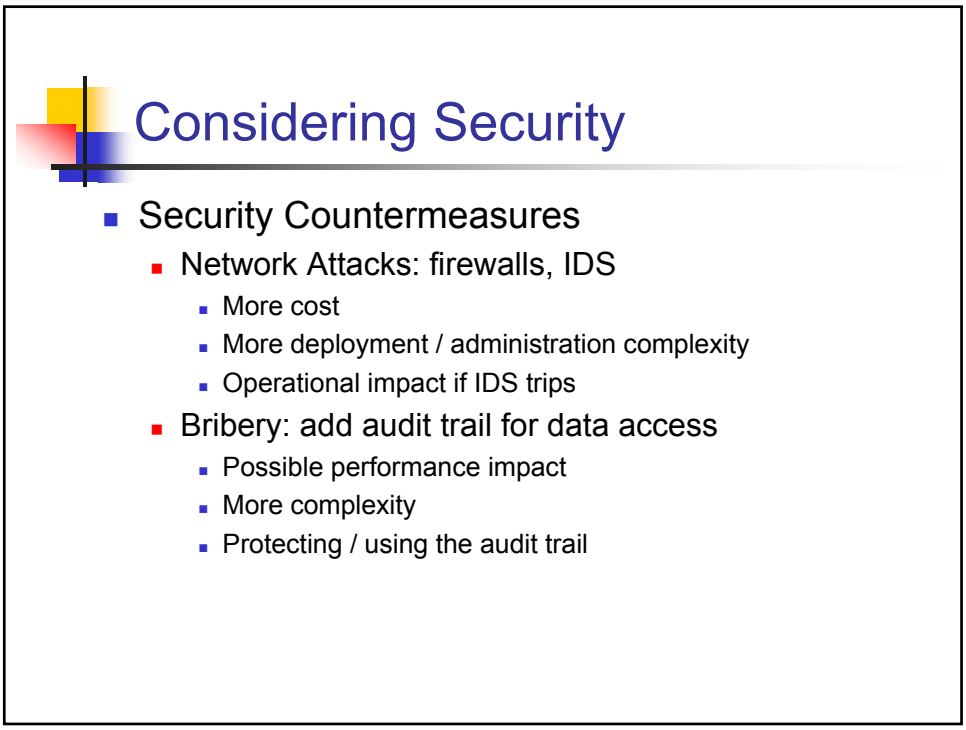
Perspectives Example: Security

- The architecture we've described is credible
- What would happen if the system needed to protect the system's information?
  - Justice community system for criminal intelligence

Considering Security

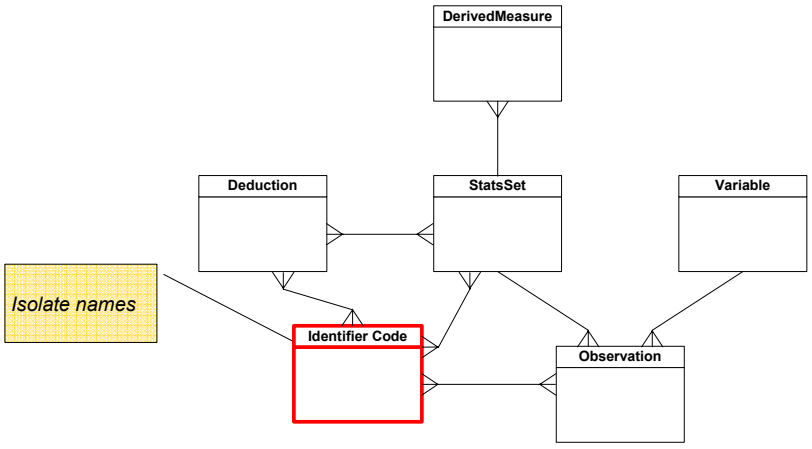
- Sensitive Resources
  - The data in the database
- Security Threats
  - Operators stealing backups
  - Administrators querying data, seeing names
  - Bribing investigating officers
  - Internal attack on the database via network


Considering Security
Security Countermeasures
Backups: encrypt data in the database
How about performance?
Does this make availability (DR) harder?
Seeing names: use codes instead of names, protect codes at higher security level
More development complexity
Possible performance impact


Considering Security
Security Countermeasures
Network Attacks: firewalls, IDS
More cost
More deployment / administration complexity
Operational impact if IDS trips
Bribery: add audit trail for data access
Possible performance impact
More complexity
Protecting / using the audit trail

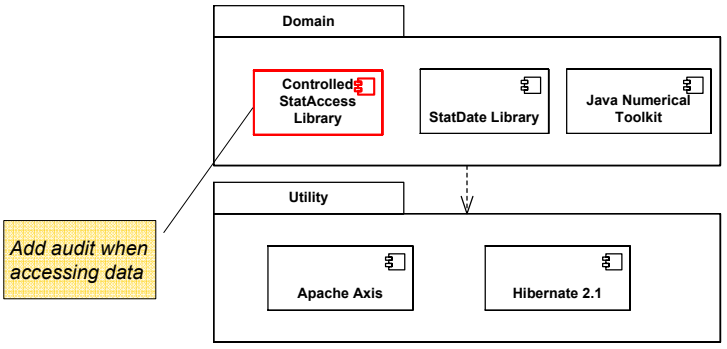
Considering Security

- Information View Impact



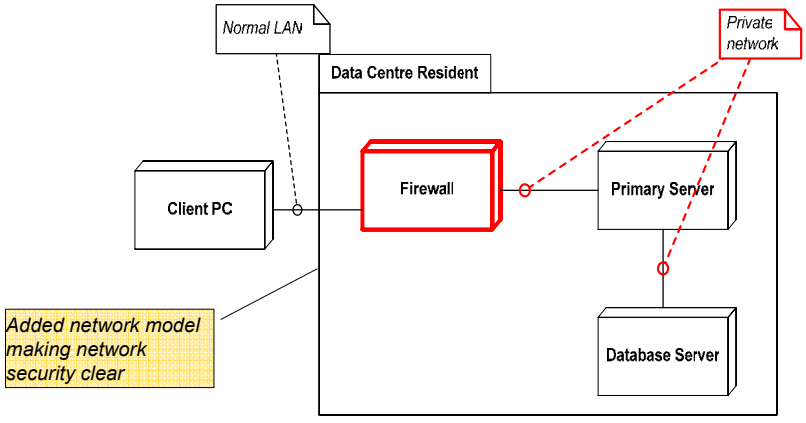
Considering Security

- Development View Impact



Considering Security

- Deployment View Impact



Considering Security

- Other Impact
  - Need IDS added to Development view
  - Need to capture impact on Operational view
  - Need to consider impact on availability
  - Need to re-work performance models to allow for database encryption, audit, …
- Note the need to change many views
- This is “architecturally significant”

The Present - Technology

- Today it's a design time game
  - Most architecture lost as we move to code
  - Even with so called MD**A** – the "A" doesn't survive
- Some styles codified in technologies
  - Grid, P2P, client/server, tuple space
- First-class connectors in some places
  - Messaging oriented systems, ESBs, …
- First tools for architects appearing
  - Lattix, Sotograph, Aspects, Troux's Metix (for EA)

The Present - Politics

- Everyone's an architect
  - 10 years technical experience => "architect"
- Language of software architecture widely used
  - Even if rarely defined or understood
- Products sold through architecture
  - .NET, J2EE, SOA, distributed caches
  - Leads to mass confusion about "architecture"
- Agile / architecture tension is fairly high
- Competing professional organisations
  - IASA, WWISA, GEAO, AEA, …

Topics

- Introducing Software Architecture
- The Past
- The Present
- **The Future**

The Future - People

- Better defined role
  - Architect vs. developer, technologist, tester or PM
  - Helps relationships with others
- Career track recognition
  - Agreement of key skills and responsibilities
  - Possibly certification (e.g. Microsoft, IASA, GEAO)
- One or more key professional bodies emerge
  - Probably IASA, perhaps others
- Education
  - MSc in software architecture perhaps?

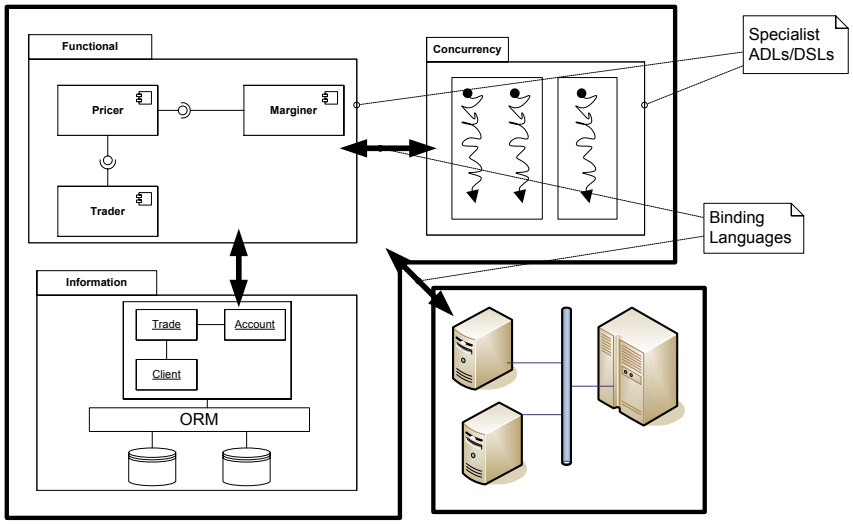
The Future - Process

- Standardised practice
  - domain specific approaches
  - real time vs. transactional vs. data centric vs. …
- Different levels of architectural process in use
  - from “agile” to “SEI” (or “kennel” to “skyscraper”)
- Design decisions will become first class
  - move focus from *structure* to *rationale*
- Fundamental agreed definitions
  - need to decide if necessary or even desirable?

The Future - Technology

- Moving architecture to runtime
  - Views in the running system
- Better description languages & tools
  - Executable and queryable architecture description
- Architecture in the running system
  - ADLs / DSLs / Aspects
- Architect-specific tool support
  - Lattix and Sotograph are just early examples
  - Modelling and construction ripe for development

Runtime Architecture



The Future - Politics

- Someone will win the hearts and minds
  - IASA?
- Selling to architects will get more intense and effective
- The agile / architecture tension will settle down
  - Both will realise where their strengths are
- More research / practice alignment?
  - WICSA6 and WICSA7 perhaps!

Topics

- Introducing Software Architecture
- The Past
- The Present
- The Future
- **Summary**

Summary (i)

- Software architecture is still young
  - really a product of 1995 – 2005
- Mainstream since about 2002
- Good core of knowledge emerging
  - approaches and techniques
- Some agreement on fundamentals
  - stakeholders, structures, qualities
  - understanding, designing, trading-off, delivering
- Much to do to raise level of sophistication
  - description, analysis, runtime representation

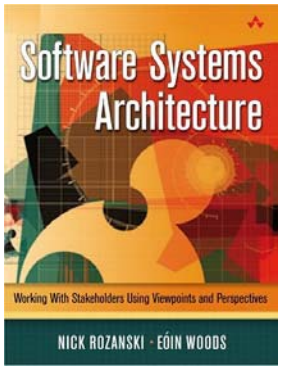
Summary (ii)

- Finally research & practice meeting
  - WICSA 5, IASA, Microsoft, …
- Better design time tools will come
  - describe and analyse architectures
  - create architectures using dedicated languages
  - beyond boxes and lines
- The future is architecture in the running system
  - too much is lost today
  - architecture description as an executable deliverable

To Learn More

Software Systems Architecture: Working With Stakeholders Using Viewpoints and Perspectives

Nick Rozanski & Eoin Woods
Addison Wesley, 2005



http://www.viewpoints-and-perspectives.info

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Comments and Questions?