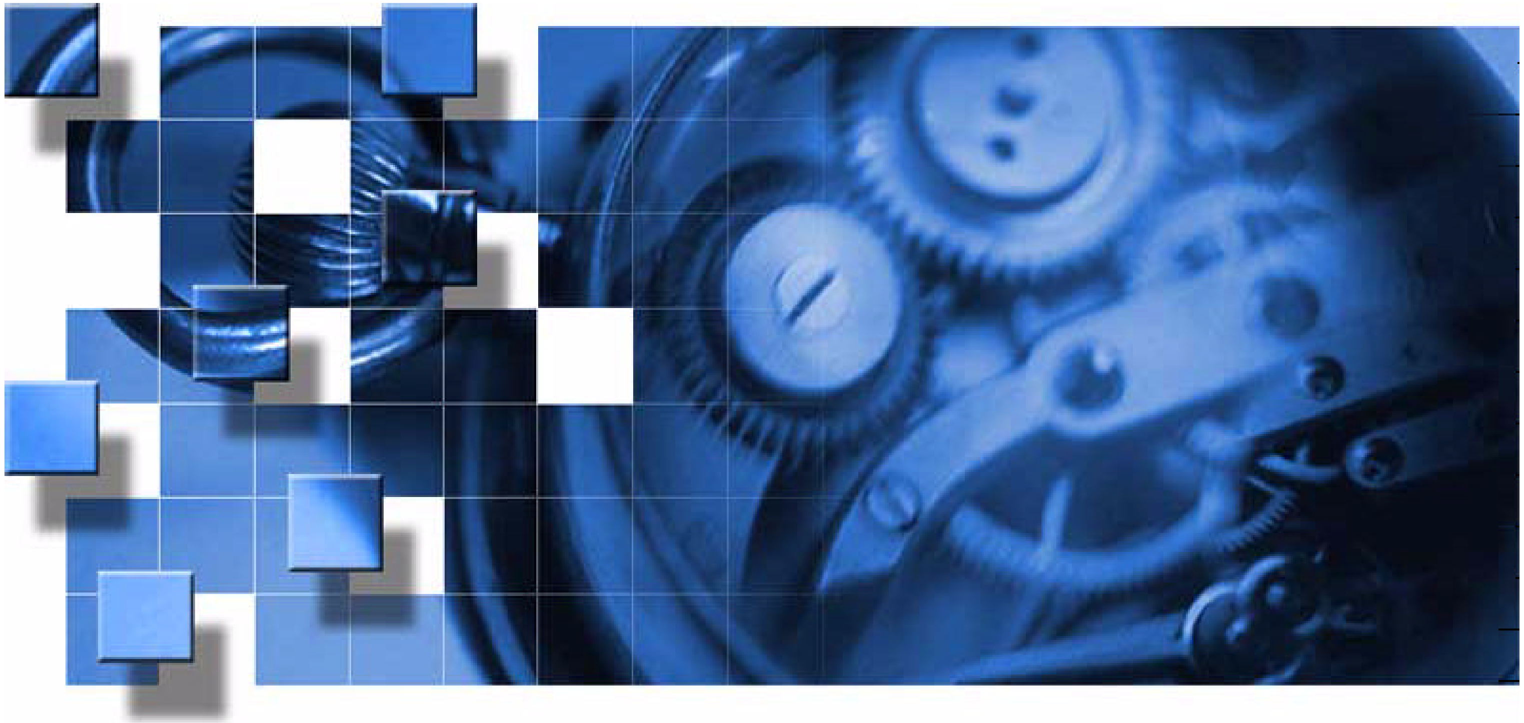
2_A IT Architecture and IT Architects

IBM Global Services



IGSMethod Architectural Thinking

At the end of this unit you should be able to:

OBJECTIVES

- ► **...Understand what IBM means by "IT Architecture"**
- ► **...Understand what IBM means by "Architectural Thinking", and appreciate how IGSMethod helps**
- ► **...Identify the qualities of a "good" IT Architecture**
- ► **...Begin using the language of IT Architects**
- ► **...Recognise that the IGSMethod does not think for you!**

Agenda

- ►**What is (IT) Architecture?**
- ►**What makes a "good" IT Architecture?**
- ►**What are the characteristics of a "good" IT Architect?**
- ►**How do IBM IT Architects communicate their designs?**
- ►**Summary**

What is Architecture?

- **"Many things to many men"!**
  But when asked, several eminent IBM IT Architects said...
  - "A high level and somewhat abstract description of the shape of something, which design and development convert into reality"
  - "A consistent and proven set of rules and principles used to guide the design process"
  - "Consistent frameworks of stuff for ensuring teams & individuals can co-operate, based on a shared vision of the solution"
- **What do you think? Let's brainstorm a few suggestions...**

Note: This foil has speaker notes

Architecture is different from Design...

▶ From the Oxford English Dictionary:

- **Architecture:**
  - "The art or science of constructing...; a special method or style of structure, (also, architronics <is the> "Systematic arrangement of knowledge")
- **Architect:**
  - "One who...prepares plans of edifaces and...superintends their erection; One who...frames any complex structure"
- **Design:**
  - noun: "the combination of details which go to make up a work"
  - verb: "to make the plans and drawings necessary for construction"
- **Designer:**
  - One who makes designs...for the constructor"

Note: This foil has speaker notes

Architecture provides a guide for Design

- **An Architecture provides a framework and a "set of rules" for the act of designing a particular thing**
  - **When building a bridge, house, church or the like, there are many architectures to choose from - each with strengths and weaknesses for different circumstances:**
    - **Churches:** Roman, Norman, Gothic....
    - **Bridges:** Suspension, Box-girder, Cantilever....
  - **There can be many individually designed instances of each particular architectural style, for example (see next foil):**

Architecture	**Design**
Suspension Bridge:	**Forth Road Bridge (Scotland), Golden Gate (San Francisco), Tacoma Narrows (NY)**
Arch Bridge:	**Sydney Harbour Bridge, Tyne Bridge (Newcastle, England)**

Five Designs, two Architectures...

Arch

Sydney Harbour

Tyne Bridge, Newcastle

Millenium Bridge, Gateshead

Suspension

Golden Gate Bridge

NEW Tacoma Narrows

So you need good Design AND good Architecture!

- **"Good" Design is internally "self consistent", embodying a vision (an architecture) which provides an overall view of how the whole thing will hang together**
  - Each of these bridges has good "internal" design

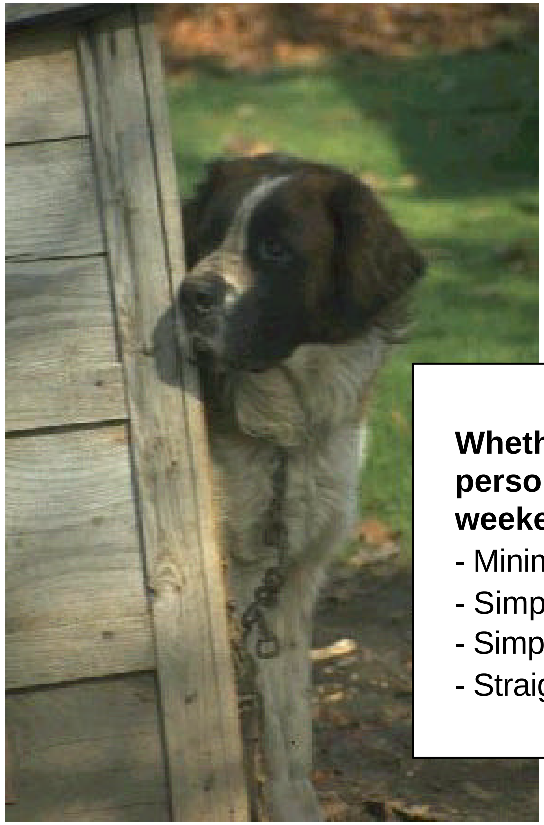
- **But a <u>GOOD</u> Design also needs to be "consistent with the wider world in which it exists"**
  - All except the original Tacoma Narrows bridge (1960s) show good "fit" to the world.
    (Wind generated harmonic vibration led to its collapse)
  - The "winking eye" footbridge in London is another good "bad" example (2000)
    (Traffic generated vibrations led to unacceptable bridge movement)

- **Remember the external context:**
  - a chair in a room,
    a room in a house,
    a house in a city plan,
    a city plan in a national vision..."

Whatever is being designed and built, there is always an underlying architecture, shaping the design decisions...

...or whether it is something a bit bigger...

- Complex Tools
- Explicit Planning
- Extensive Design
- Specialised Skills



Whether it is a one person project for the weekend...

- Minimal modelling
- Simple implicit process
- Simple tools
- Straightforward Skills

- <u>BOTH</u> need...
  - A vision
  - Design principles
  - A model
  - Basic building blocks
  - Success criteria
  - Building standards
  - Management
  - A plan
- <u>...to some degree!</u>

So an IT Architecture is not...

- **Some common mis-statements about Architecture:**
  - Architecture and design are the same thing
  - Architecture and infrastructure are the same thing
  - <my favorite technology> is the architecture
  - A good architecture is the work of a single architect
  - Architecture is flat, one blueprint is enough
  - Architecture is just structure
  - System architecture precedes software architecture
  - Architecture cannot be measured and validated
  - Architecture is a Science
  - Architecture is an Art
  - It is the solution's technology/infrastructure/data/network/etc.
- **These are from Grady Booch (Rational) - but often heard around IBM!**

...An IT Architecture is:

- **A consistent framework of rules, policies and guidelines, which together provide the guidance and support necessary for the detailed design of the IT based business solution."**
  - An Architecture can be developed (some would say designed!) specially for a project - often called "Whiteboarding"
  - An architecture can be selected and adapted from a range of previously available options - referred to as "pattern based thinking"

- **A formal definition for IBM (ADS):**
  - **IT Architecture:**
    - "...is the structures of the system, which comprise software and hardware components, the externally visible properties of those components, and the relationships amongst them"
      - **Adapted from [Bass, Clements and Kazman, 1998]**

From Grady Booch, Rational

Agenda

- ► What is (IT) Architecture?
- ► **What is "Architectural Thinking"?**
- ► What makes a "good" IT Architecture?
- ► What are the characteristics of a "good" IT Architect?
- ► How do IBM IT Architects communicate their designs?
- ► Summary

What is Architectural Thinking?

- **"Many things to many men"!**
  But when asked, several eminent IBM IT Architects said...
  - "Finding a strategy (or approach) to problem solving"
  - "Bringing order and form from confusion and chaos"
  - "Working from requirements towards the solution, and not the other way around"
- **What do you think? Let's brainstorm a few suggestions...**

Note: This foil has speaker notes

What is IT Architecture and IT Architectural Thinking to IBM IT Architects?

- **"Many things to many men"!**
  But when asked, several eminent IBM IT Architects said...
  - "The design of the IT solution's application to ensure the functional requirements are met"
  - "The design of the IT solution's infrastructure to ensure the non-functional requirements are met"
- **What do you think? Let's brainstorm a few suggestions...**
- **There are three distinct aspects to IT Architectural Thinking**
  - **Which we will now discuss in turn...**

Note: This foil has speaker notes

Agenda

- **What is (IT) Architecture?**
- **What is "Architectural Thinking"?**
  - Part 1: "Solving Problems Top Down"
- **What makes a "good" IT Architecture?**
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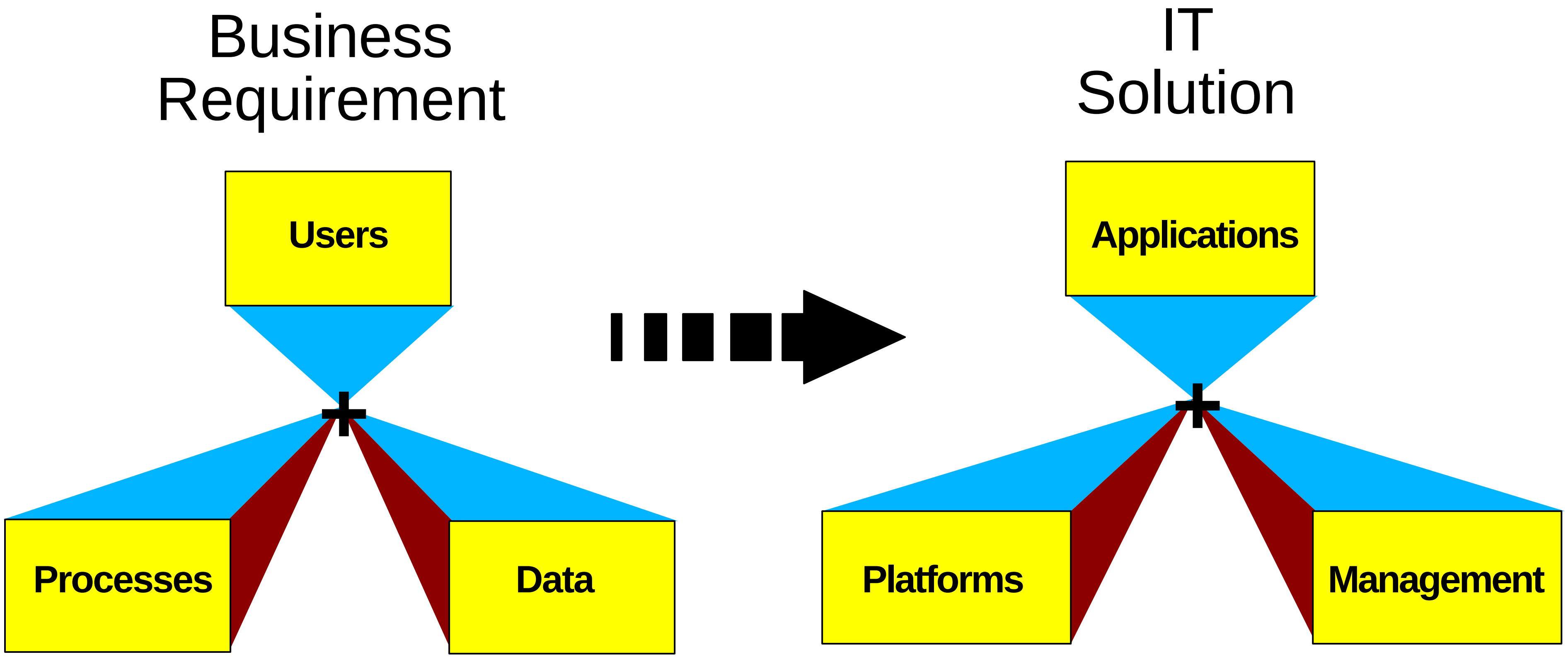
Architectural Thinking, part 1: solving problems "top down"



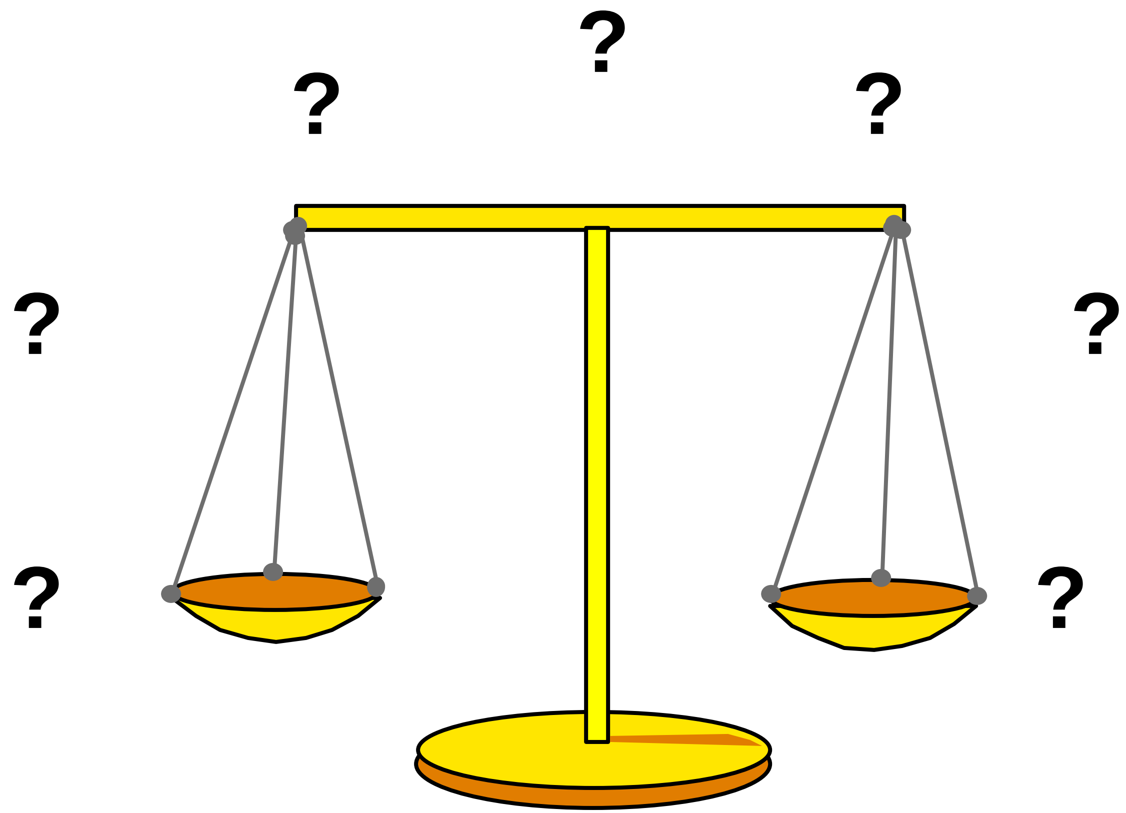
- But delivering the "functional requirements" is not enough"...

What else must an IT Solution Satisfy?

Users

Data

Processes

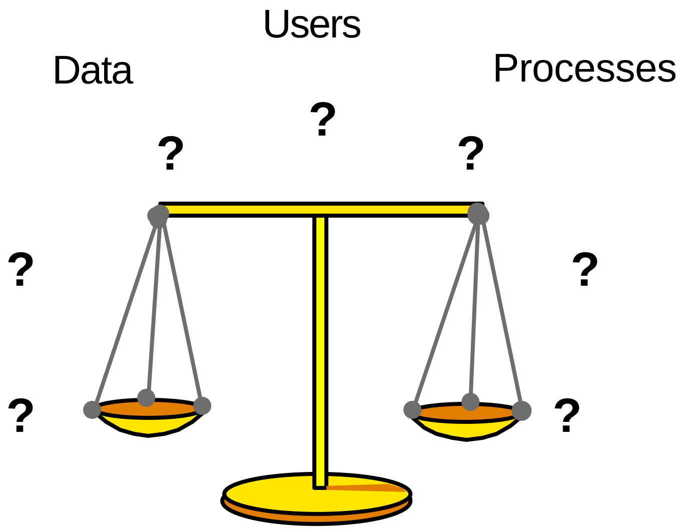


Think for a moment...

- What other "things" make a difference to the successful implementation and operation of an IT based business solution?

- What "characteristics" does the delivery and operation of the solution have to have?

- Spend a couple of minutes jotting down your thoughts
  - We'll discuss them in a moment...



Some sample "Non-functional Requirements"!

Users

Data

Processes

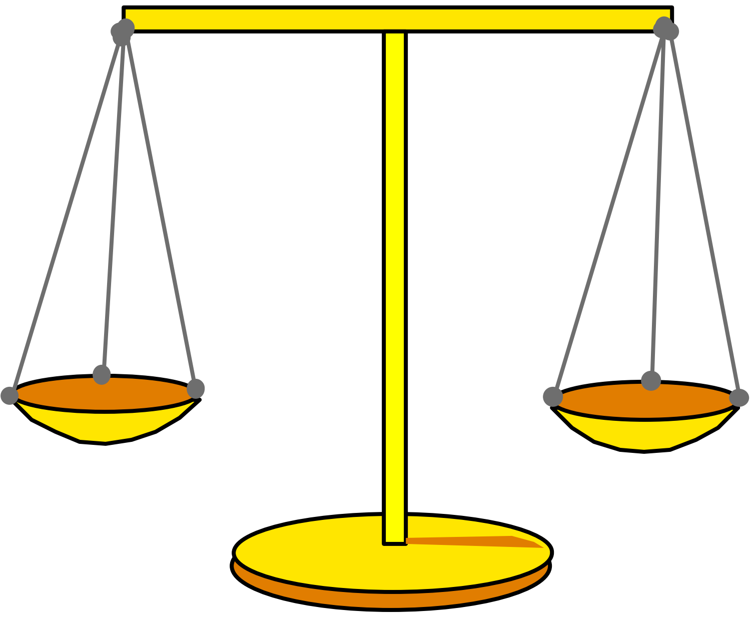
Availability

Cost

Current IT

Project
Timescales

Skills (User and IT)



Performance

Data Currency

Use of New
Technologies

Process &
Data Integrity

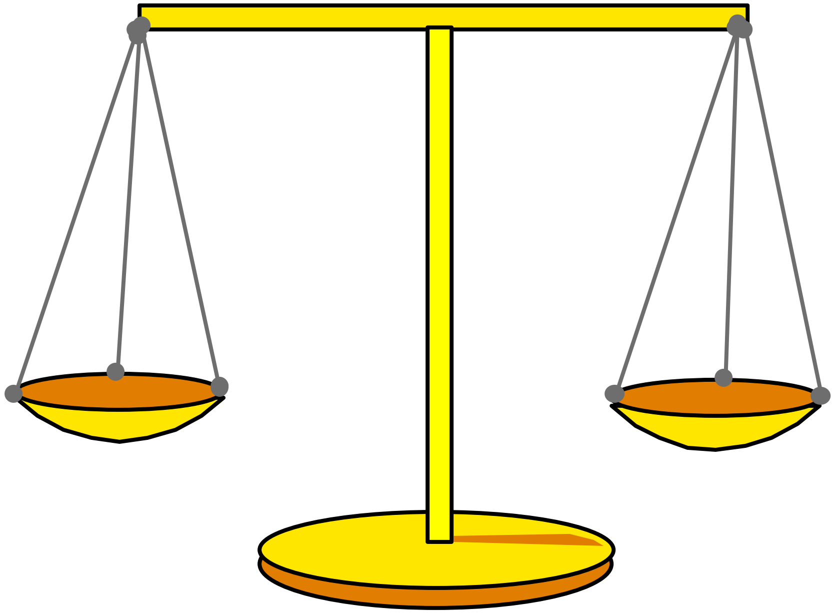
System
Management

Security

It's all a question of compromise and balance

1) Achieving the required "Business Functions"...

2) ...within the constraints and givens...



3) ...*and* the required "Service Levels"...

4) ...*and* with the right qualities

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- **What is (IT) Architecture?**
- **What is "Architectural Thinking"?**
  - Part 1: "Solving Problems Top Down"
  - Part 2: "Bringing Order from Chaos"
- **What makes a "good" IT Architecture?**
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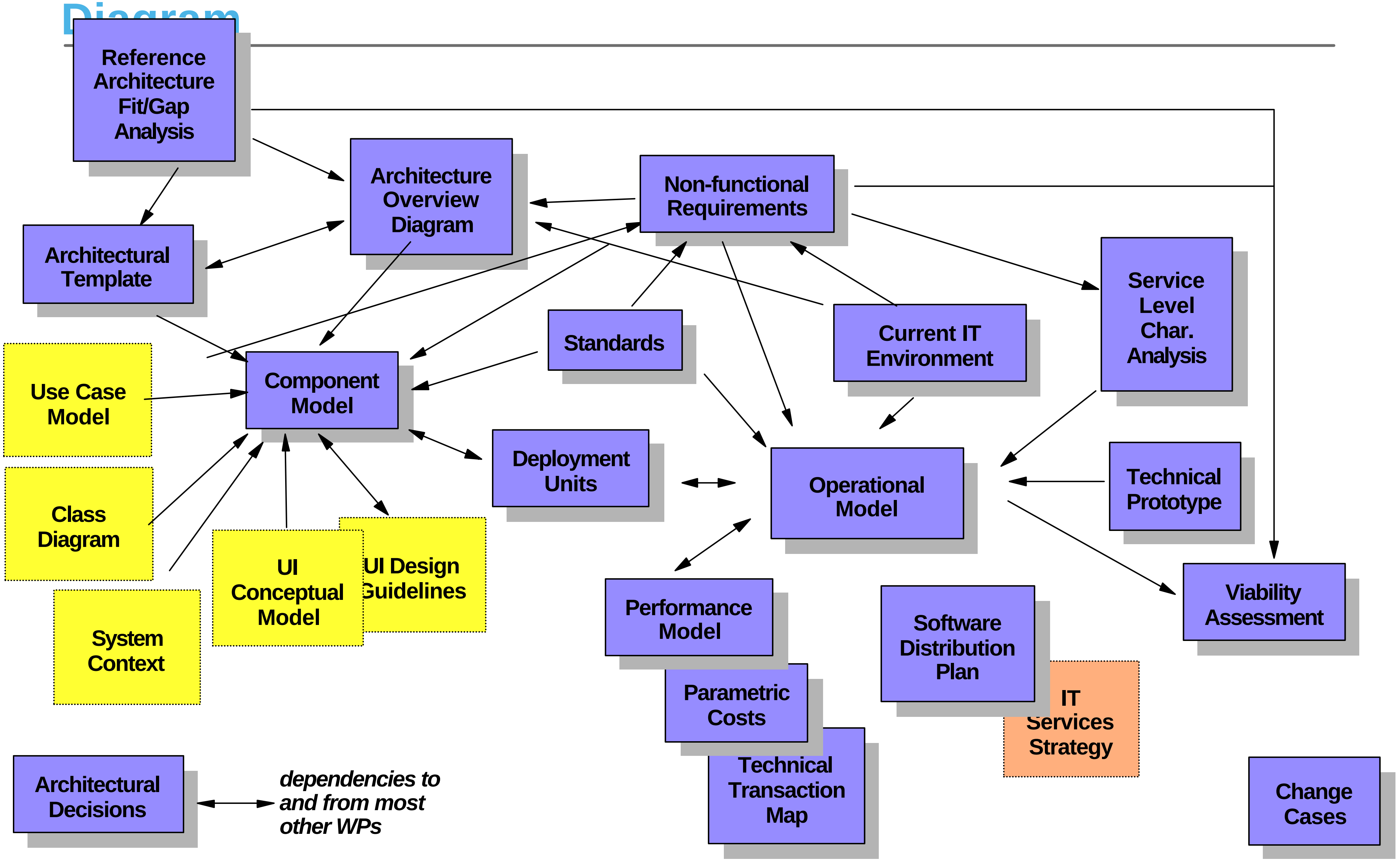
Architectural Thinking, Part 2:
Bringing order from chaos ("separation of concerns")

- **"Architecture" covers a lot of stuff...**
  - Requirements & Constraints
    - Functional stuff
    - Non-functional stuff
    - Project stuff
    - Existing IT and business stuff
  - Solution Design & Implementation
    - Application
    - Infrastructure
    - Systems Management

- **How does an IT Architect tackle all this?!?**

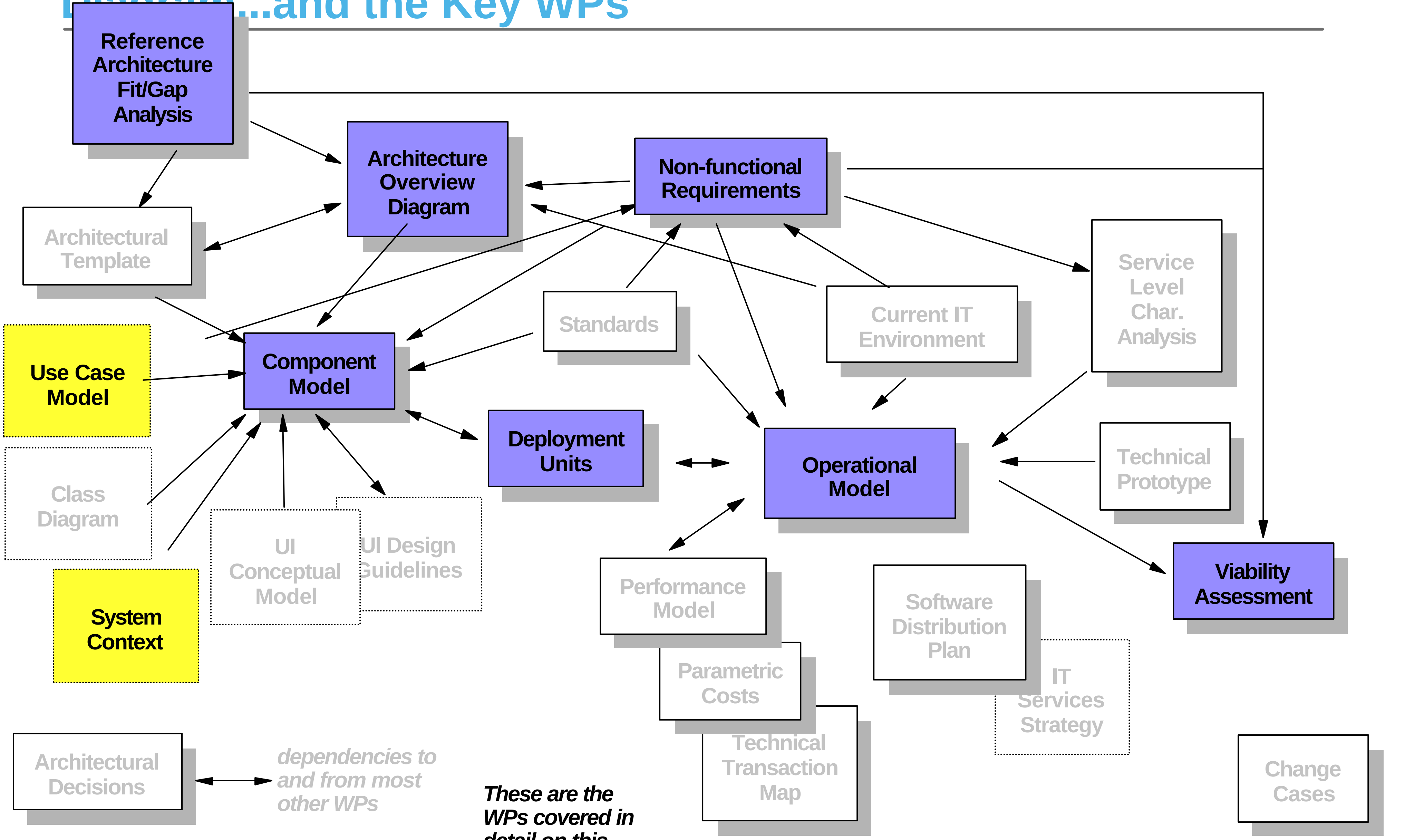
- **By using the IGSMethod!**
    - The IGSMethod provides a mechanism for separating out all these concerns in the architecture space - a structured collection of ARCHITECTURE RELATED WORK PRODUCTS

The Architecture Domain Work Product Dependency Diagram



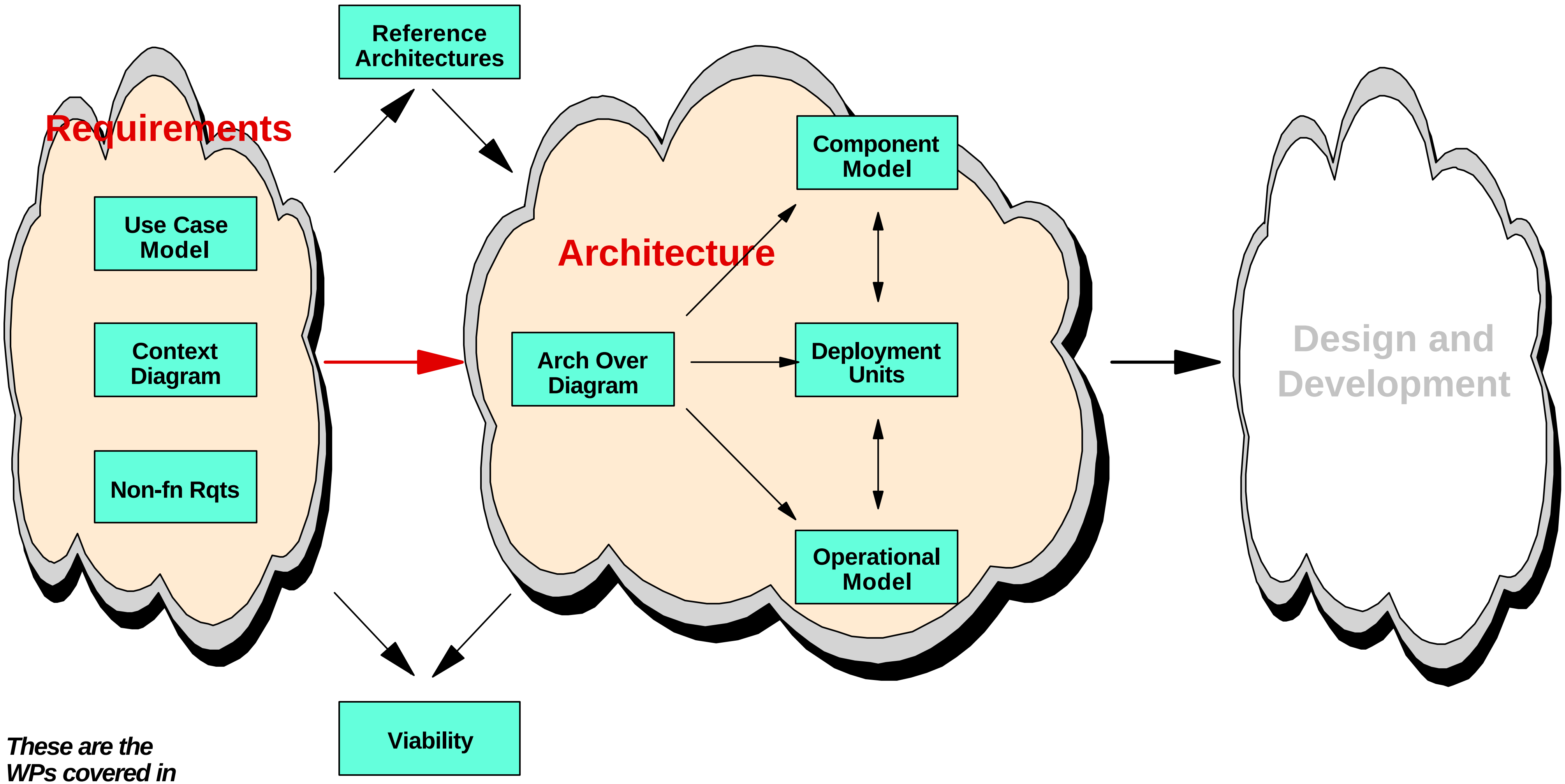
dependencies to and from most other WPs

The Architecture Domain Work Product Dependency Diagram...and the Key WPs



These are the WPs covered in detail on this class.

Or, re-presented in a "top down" fashion (OK - left to right!)



These are the WPs covered in detail later on in this class.

Note: *This is by NO means a complete collection of the work products needed by an IT Architect! It is intended to illustrate the relationships between the central work products. Please refer to the appropriate WPDDs in the IGSMethod for a complete picture.*

It is vitally important to distingush the functional and operational aspects of architecture

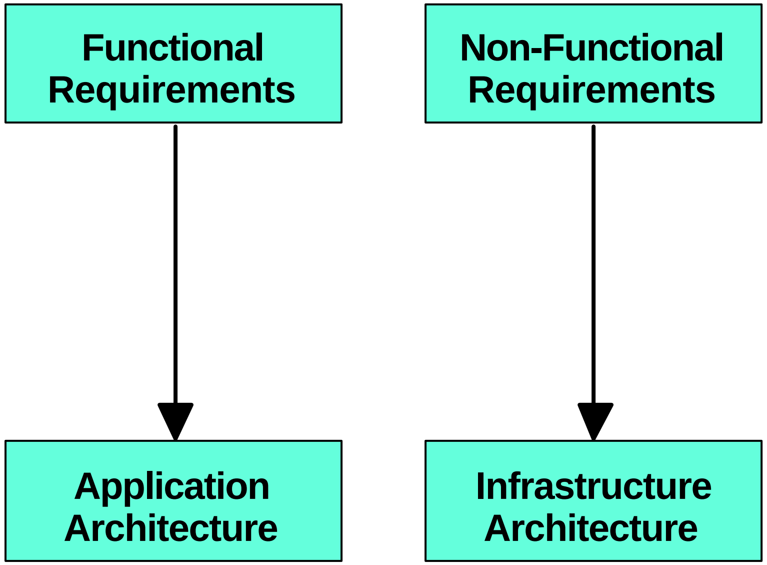
- **The Functional aspects of Architecture**
  - Describe the structure of software components (of all kinds),
  - ...their dynamic behaviour (collaboration),
  - ...and their interfaces.
  - Embodied in the **Component Model** work product

- **The Operational aspects of Architecture**
  - Includes the network topology (hardware nodes, locations, etc.),
  - ...and describes what runs where (component placement).
  - It ensures the achievement of the solutions service level characteristics (performance, availability),
  - ...and describes the management and operation of the IT system.
  - Embodied in the **Operational Model** work product

Each aspect is focused on a specific Work Product:

- **The Operational Model...**
  - "Represents the geographic structure of the IT solution, showing how the various parts of the IT solution's application, data and underpinning infrastructure (including hardware, software, networks and systems management) are physically distributed."
    - Geography is not the only topological issue - there are other influences on the placement of the components in an IT solution, such as ownership.
- **The Component Model...**
  - "Represents the static structure and dynamic behaviour of the components which make up the IT system, described in terms of the relationships (interfaces and operations) which exist between them."
- **Much much more on both of these later!!!**

But does Operational = "non-functional", Application = functional"? No!



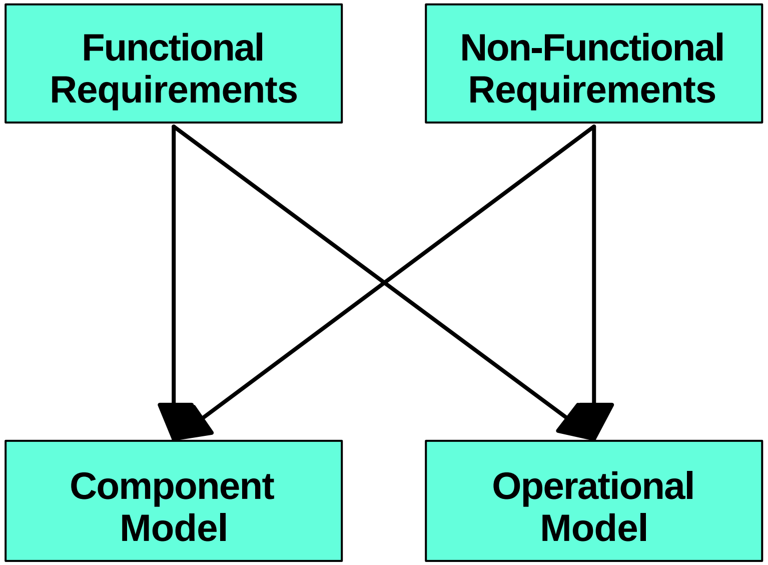
Functional Requirements

Non-Functional Requirements

Application Architecture

Infrastructure Architecture

- ▶ **Pre-IGSMethod**



Functional Requirements

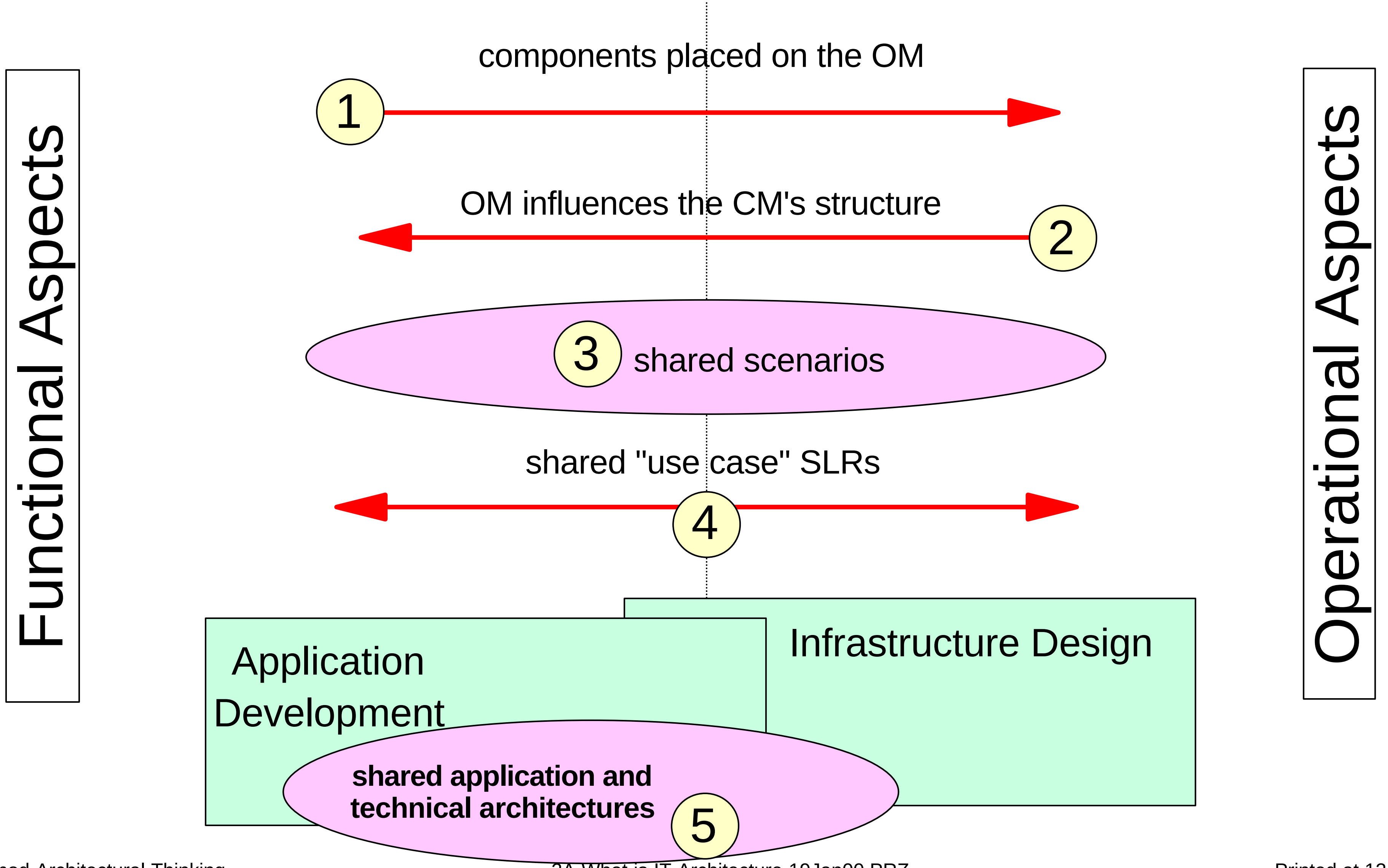
Non-Functional Requirements

Component Model

Operational Model

- ▶ **IGSMethod**

There are at least five mechanisms integrated into the Method to ensure these functional and operational aspects are co-ordinated...



Functional Aspects

Operational Aspects

1 components placed on the OM

2 OM influences the CM's structure

3 shared scenarios

4 shared "use case" SLRs

Application Development

Infrastructure Design

5 **shared application and technical architectures**

Agenda

- ► **What is (IT) Architecture?**
- ► **What is "Architectural Thinking"?**
  - – Part 1: "Solving Problems Top Down"
  - – Part 2: "Bringing Order from Chaos"
  - – Part 3: "A Structured Approach to Projects"
- ► **What makes a "good" IT Architecture?**
- ► **What are the characteristics of a "good" IT Architect?**
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- ► **Summary**

Architectural Thinking, Part 3:
A structured approach to projects

- **Organising all this Architectural stuff into manageable chunks is only part of the challenge!**
- **How does an IT Architect go about "doing it"?**
- **By using the IGSMethod!**
  - The IGSMethod provides a mechanism for helping the IT architect do the job - a structured collection of WORK BREAKDOWN STRUCTURES and TECHNIQUES which recognise the holistic nature of Architecture

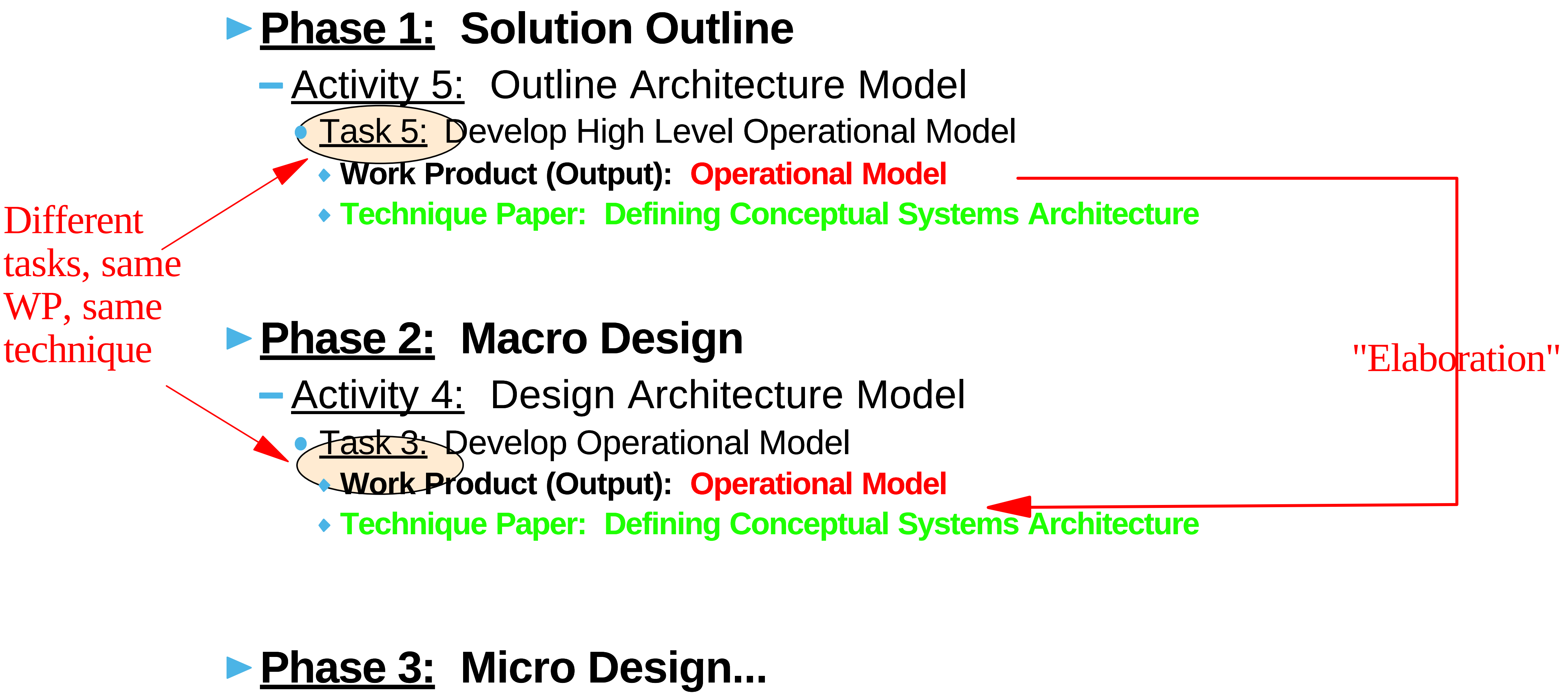
The IGSMethod provides the Architect with all the necessary functional/operational co-ordination

- **The Method allows the Component and Operational Models evolve ("elaborate") in parallel**
  - sequencing varies, depending on project context
  - elaboration points often not synchronised
  - may design components to fit Operational Model
  - may design Operational Model to support fixed Component Model

  - Changes in Operational Model (e.g. to achieve a service level) may force or enable change in the Component Model
  - Change in Component Model (e.g. to simplify coding) forces changes to placement details in the Operational Model

- **The key idea is to establish relationship early on in the project and co-ordinate consequences when either side changes**

The Method's techniques and tasks are the key to this elaboration based approach



- **Phase 1: Solution Outline**
  - Activity 5: Outline Architecture Model
    - Task 5: Develop High Level Operational Model
      - **Work Product (Output): Operational Model**
      - **Technique Paper: Defining Conceptual Systems Architecture**

Different tasks, same WP, same technique

"Elaboration"

- **Phase 2: Macro Design**
  - Activity 4: Design Architecture Model
    - Task 3: Develop Operational Model
      - **Work Product (Output): Operational Model**
      - **Technique Paper: Defining Conceptual Systems Architecture**

- **Phase 3: Micro Design...**

So the degree of accuracy, precision and detail within a work product can improve through the project's phases

Work Product	Solution Outline	Macro Design	Micro Design
Architecture Overview	Complete		
Operational Model	High Level	Complete, summary system wide	Detailed, release wide
Component Model	High Level	Complete, summary system wide	Detailed, release wide

Note: *The case study used on this class is approximately aimed at this level of accuracy, precision and detail*

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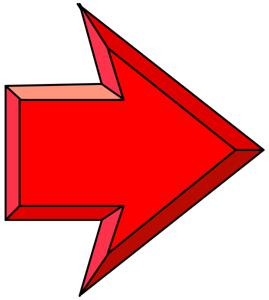
As well as ensuring the design achieves the requirements (functional and non-functional), an IT Architecture must be based on sound architectural principles

- ► **Both general "good practice"**
  - Separation of concerns
  - Information hiding
  - Design by interface
  - Separation of interface and implementation
  - Partitioning / distributing responsibilities
  - ...

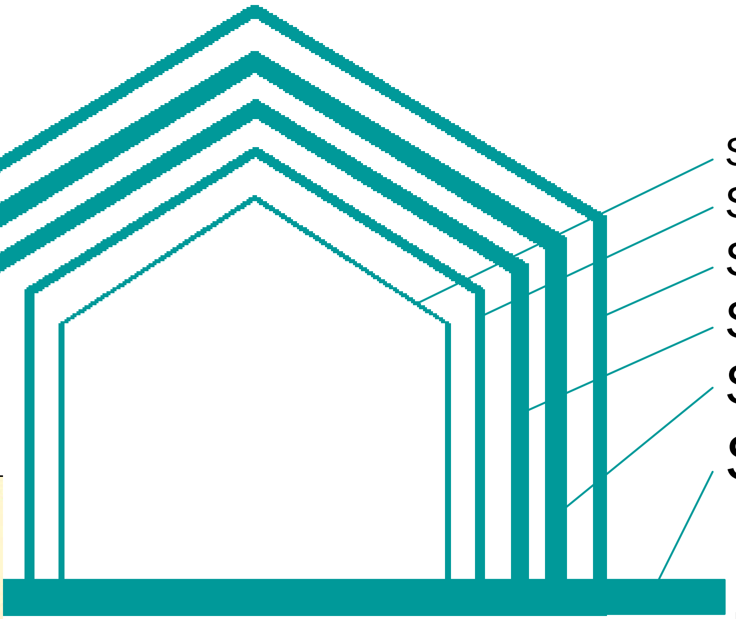
- ► **And driven by specific project or client needs:**
  - Data
  - Networking
  - Systems Management
  - Application Development
  - Technology selection and use
  - Organization
  - and, for example: a Capacity for Change... (see next foil)



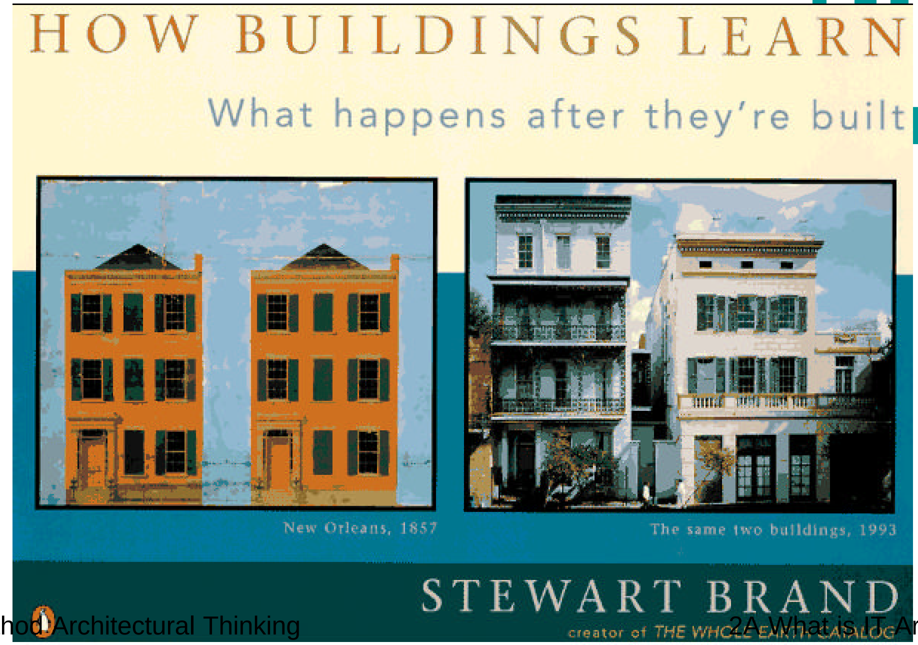
- ► **Principle:**
  - –
- ► **Motivation:**
  - –
- ► **Impact:**
  - –

For example, a key attribute of an IT systems today is a "capacity for change" - like buildings!

- Question:
  - What architectural principle provides for a Capacity for change?
- Answer:
  - An overall structure which provides a clean, flexible relationship between the elements (layers) of the solution...



From "How Buildings Learn"
[S Brand, Viking 1994]



HOW BUILDINGS LEARN
What happens after they're built
New Orleans, 1857
The same two buildings, 1993
STEWART BRAND
creator of THE WHOLE EARTH CATALOG

Two Buildings, originally the same, but very different histories:

Both had rapid turnover of tenants with differing needs - both grew, they diverged and their skins changed markedly.

This capcity for change was enabled because of their architecture and the choice of technologies used in their construction

So a good Architecture (1)...

- Readily absorbs new function, with effort proportional to size of change.
- Breaks down the complexity to supports parallel development, incremental construction, and isolated verification of parts, yet which together can be managed to the completion and deployment of the whole.
- Structures components so that each has a cohesive set of responsibilities, avoiding redundancy and rework.
- Optimizes component structure and partitioning so that Service Level Requirements can be delivered.

So a good Architecture (2)...

- ► **Analyzes required and possible future functionality so that required technical (or “infrastructure”) components can be identified.**
- ► **Provides a basis for the specification of the physical computer systems on which the IT System will execute and the mapping of components onto these computer systems.**
- ► **Is based on established and published practice with known characteristics, risks and limitations.**
- ► **Can be understood, modelled and reasoned about without going back to first principles or reading the code.**

The architecture depends on viewpoint and context and can be represented in multiple ways

- **The concept of architecture is one of abstraction (hiding of details).**
- **We hide the details in a particular context - switching context requires that we change what is hidden.**
- **Architecture requires one to consider multiple system qualities which may conflict with each other; therefore, tradeoffs are required, which may need to be revisited in later phases.**
- **Architectural Views, also influence the architecture - at times it is just the representation of the architecture which needs to change.**
- **Our strategy consultants (EA etc.) define architecture as a framework for decision making.**

A good IT architecture serves multiple purposes, including:

- Assisting in the analysis of service level requirements so that the means of delivering them can be designed into all aspects of the solution
- Providing the rules of composition / decomposition of system elements
- Breaking down the complexity of the IT system so that developers can analyze and design components and nodes in relative isolation from each other (while still coordinating activities)
- Analyzing the required functionality so that required technical components (or "infrastructure") can be identified
- Providing a basis for the specification of the physical computer systems on which the IT system will execute and the mapping of components onto these computer systems
- Defining the structuring and strategy for connection of system elements
- Providing a decision trail which allows the system to evolve over time - in an organized and well understood way

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What skills should an Architect possess (1)?

► Once, long ago:

- "The ideal architect should be a man [or woman] of letters, a mathematician, familiar with historical studies, a diligent student of philosophy, acquainted with music, not ignorant of medicine, learned in the responses of jurisconsults <*lawyers*>, familiar with astronomy and astronomical calculations."

  - ◆ **Vitruvius, circa 25 BC**

What skills should an Architect possess (2)?

- **But today, in IBM:**
  - From a recent Senior IT Architect Certification Letter of Support:
    - "He acts and communicates like an Architect. Maybe an obvious statement, but he has a rare skill, being able to see an IT based business solution in the round (the 'big picture') as well as having an eye for the crucial detail."
    - "He is a consummate negotiator and facilitator, but also has passion, dedication and vision."
    - "He can handle projects, and has a particular ability to "drive" teams of IT Architects towards delivering what they've said they will deliver."
      - **Anon, 2000 AD**

Who does an Architect have to be?

- **She/he must be:**
  - A Practitioner
  - A Consensus builder
  - Results oriented
  - A Generalist
  - A technology expert
- **They are not:**
  - The project manager
  - A product expert
  - A lone scientist
  - Just a top level software designer

How does an Architect approach life (1)?

► Their work...

- "Where do architects and designers get their ideas?" The answer, of course, is mainly from other architects and designers, so is it mere casuistry <*quibbling*> to distinguish between tradition and plagiarism?
  - **[Stephen Bayley (b. 1951), British design critic. Commerce and Culture, ch. 3 (1989).]**

► ...and their decisions...

- "The life of an... architect is a long (and sometimes painful) succession of sub-optimal decisions made partly in the dark."
  - **[Philippe Krutchen]**

How does an Architect approach life (2)?

- **But most importantly...**
  - "Where do architects and designers get their ideas?" The answer, of course, is mainly from other architects and designers, so is it mere casuistry <*quibbling*> to distinguish between tradition and plagiarism?
    - **[Stephen Bayley (b. 1951), British design critic. Commerce and Culture, ch. 3 (1989).]**
- **REUSE of architectural knowledge and artifacts (existing designs) is an important aspect of a good architect's approach**
  - Styles
  - Patterns
  - Reference Architectures
- **We reuse PROVEN architectures - whereever they come from!**
  - Formal (ESS) or not (other ICAP / KN / ITAD /ICM)

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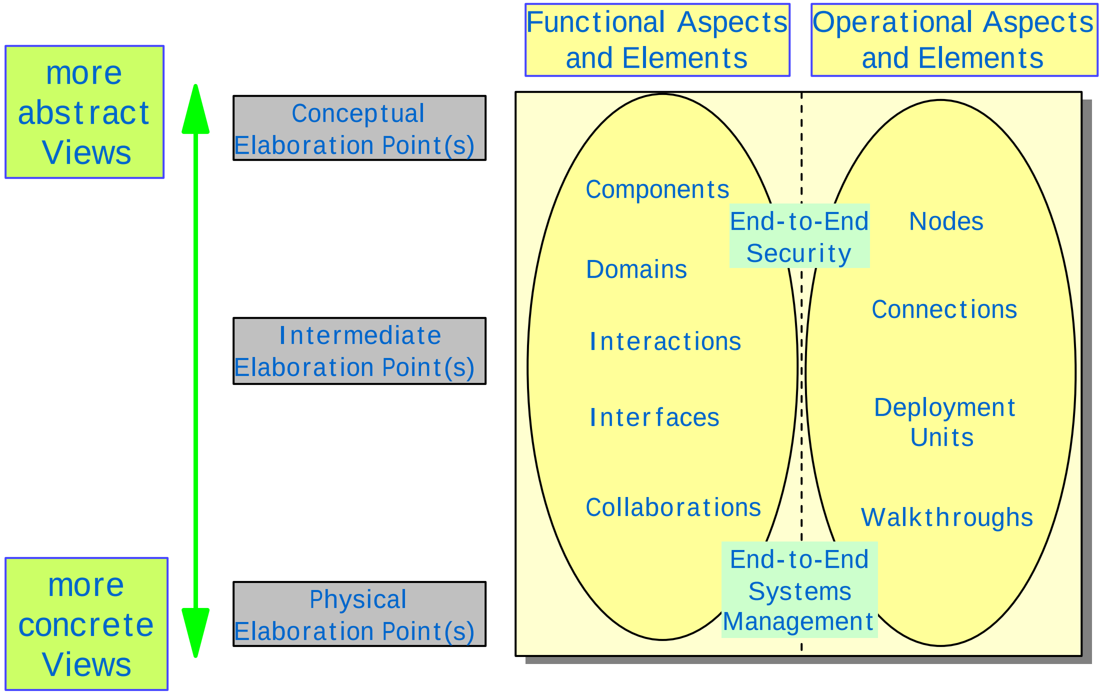
How do IBM IT Architects communicate their work?

- **In a Nutshell...**
  By using the Architecture Description Standard (ADS)!

- **A common language for Architects, world-wide**

- **ADS was developed to:**
  - facilitate reuse
  - improve communications
  - underpin IBMs' Methods


more abstract Views
more concrete Views
Conceptual Elaboration Point(s)
Intermediate Elaboration Point(s)
Physical Elaboration Point(s)
Functional Aspects and Elements
Operational Aspects and Elements
Components
Domains
Interactions
Interfaces
Collaborations
End-to-End Security
End-to-End Systems Management
Nodes
Connections
Deployment Units
Walkthroughs

ADS's language underpins the IGSMethod...

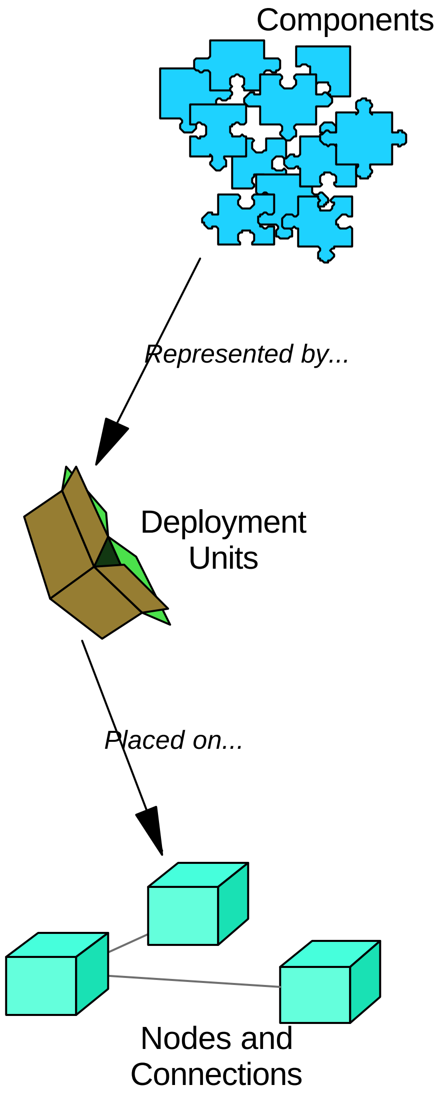
► ADS gives us a Standard Language - for example:

– Functional Aspects of Architecture -

- **Component**
  a modular unit of (software) functionality, accessed through one or more interfaces (encapsulated)
- **Subsystem**
  any subset of components in IT system
- **Collaboration**
  collaboration between components realizes a use case scenario, consisting of a sequence of component operations
- **Interaction**
  exchanges between two components, interface usage contract / protocol

– Operational Aspects of Architecture -

- **Node**
  a platform on which software executes
- **Connection**
  the physical data path between nodes, LAN, WAN, dial-up etc.
- **Deployment Unit**
  represent one or more components, placed together on a node. Execution, state and installation aspects may be separately placed



Components

Represented by...

Deployment Units

Placed on...

Nodes and Connections

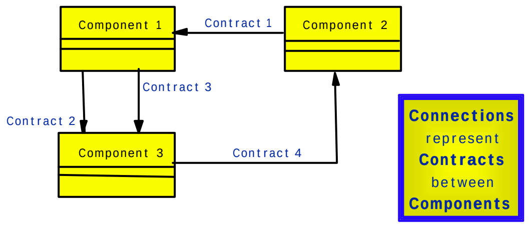
...and it provides key diagraming notations

- **ADS advocates:**
  - UML for functional aspects
    - **Static Component Model Diagrams**

      Class, Object Relationship
      UseCases
      Deployment
    - **Dynamic Component Model Diagrams**

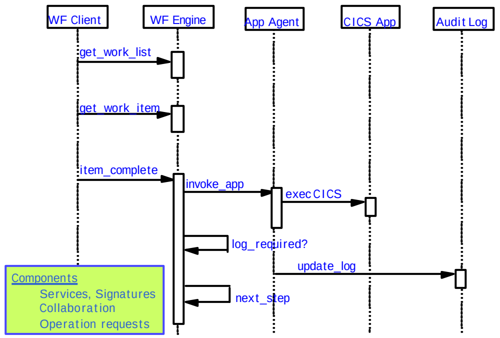
      Sequence Diagrams (Time oriented)
      Object Collaboration (Message oriented)
      State

Component Diagrams, Relationships, Connections



" a component needs other component to fulfill its obligations

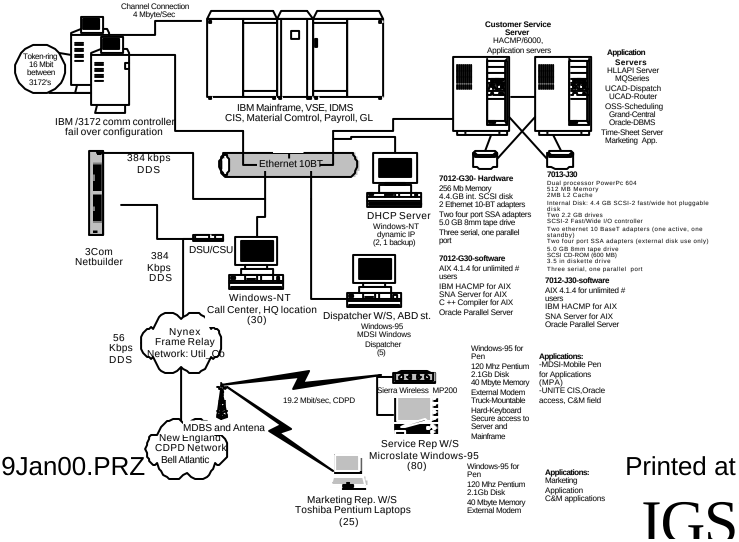
What are Component Interaction Diagrams



  - Various styles for operational aspects
    - **Static Views of the Operational Model**

      Conceptual view
      Specitfied view
      Physical view
    - **Dynamic views of the Operational Model**

      Walkthroughs



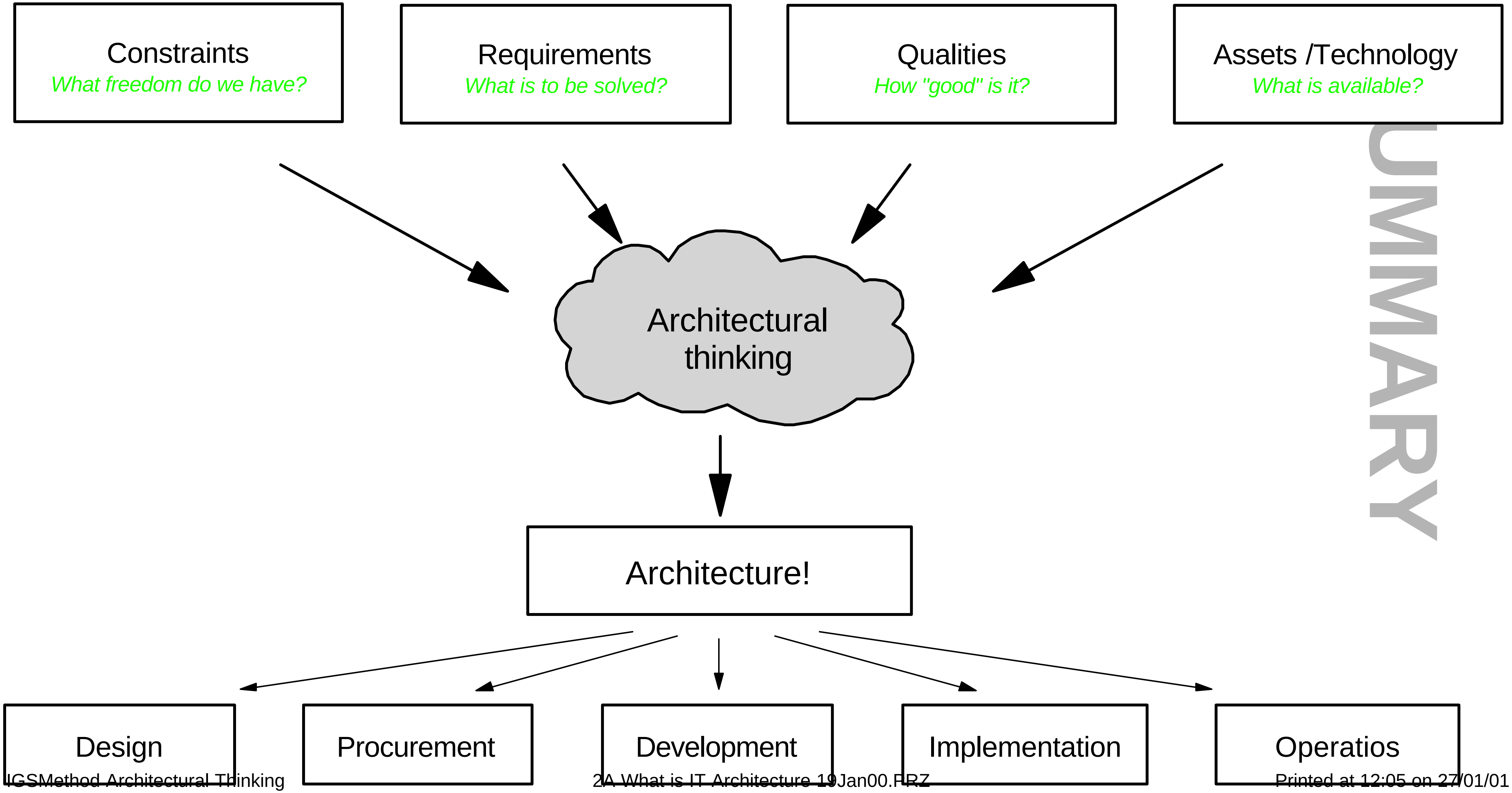
Agenda

- ▶ What is (IT) Architecture?
- ▶ What is "Architectural Thinking"?
- ▶ What makes a "good" IT Architecture?
- ▶ What are the characteristics of a "good" IT Architect?
- ▶ How do IBM IT Architects communicate their designs?
- ▶ <u>Summary</u>

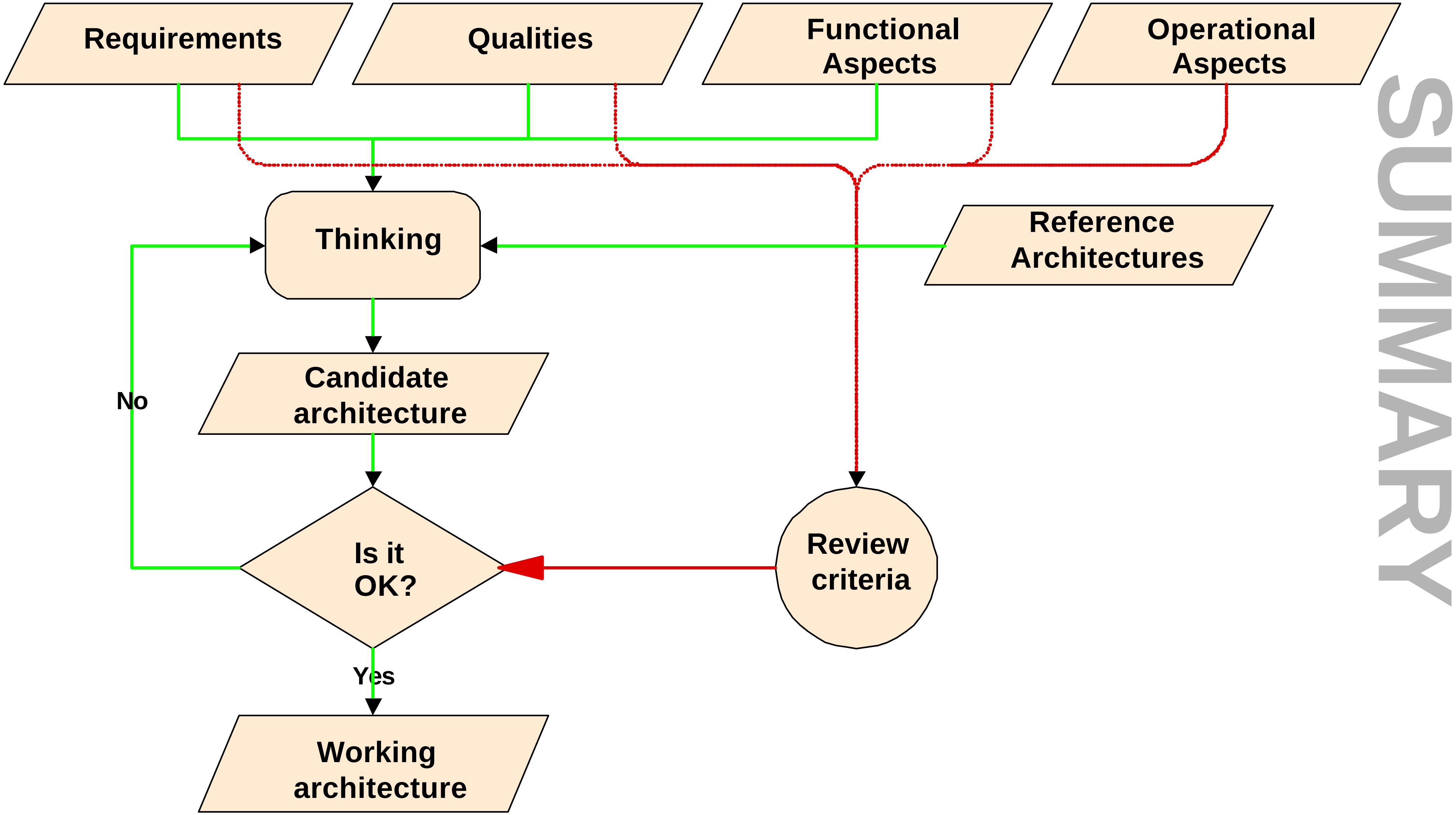
So what IS IT Architecture and IT Architectural Thinking to IBM IT Architects?

- It's **still** "Many things to many men"!
  And when asked, several eminent IBM IT Architects did say...
  - "The design of the IT solution's application to ensure the functional requirements are met"
  - "The design of the IT solution's infrastructure to ensure the non-functional requirements are met"
- **But in IBM's IGSMethod it is clear - it is BOTH!**
  - Architectural Thinking involves the **top down**, **structured** development of an IT system's **integrated** functional and operational architecture
  - Such an architecture helps ensure the design, development and delivery of an IT system which meets the business solution's functional and non-functional requirements.

Architectural thinking involves looking at inputs, the thinking process, and outputs...



...and is iterative and complex



Architectural thinking involves learning (1)...

- **...To look at the solution from the direction of requirements**
  - Not from the technology ("the answer is X, what's the problem?")
- **...To understand all aspects of the requirements**
  - Functional and non-functional
  - Avoid rushing to a solution without taking the time to define the problem being solved
- **...To understand all aspects of the solution**
  - Functional and non-functional(!)
  - Break the habit of the "I've always used this approach" method
- **...To take a structured approach**
  - "Content" - the stuff which makes up the architecture
  - "Process" - the way in which the stuff is developed

SUMMARY

Architectural thinking involves learning (2)...

- **...To use reference architectures whenever appropriate**
  - There are a variety of architecture styles and approaches available
- **...It's all a question of compromise and balance**
  - Every solution to a requirement is going to cause other problems
- **...to avoid "Gold Plating"!**
  - Enough, and no more

SUMMARY

Why should you care?

- **Do we need Architects anymore?**
  - Technology is faster, cheaper, cleverer...
- **...But systems are increasingly complex**
  - multi-tier, multi-technology, multi-skills
  - multi-release, rapid release, changing requirements
- **The architect is responsible for ensuring the system *works* - functionally and operationally**

SUMMARY

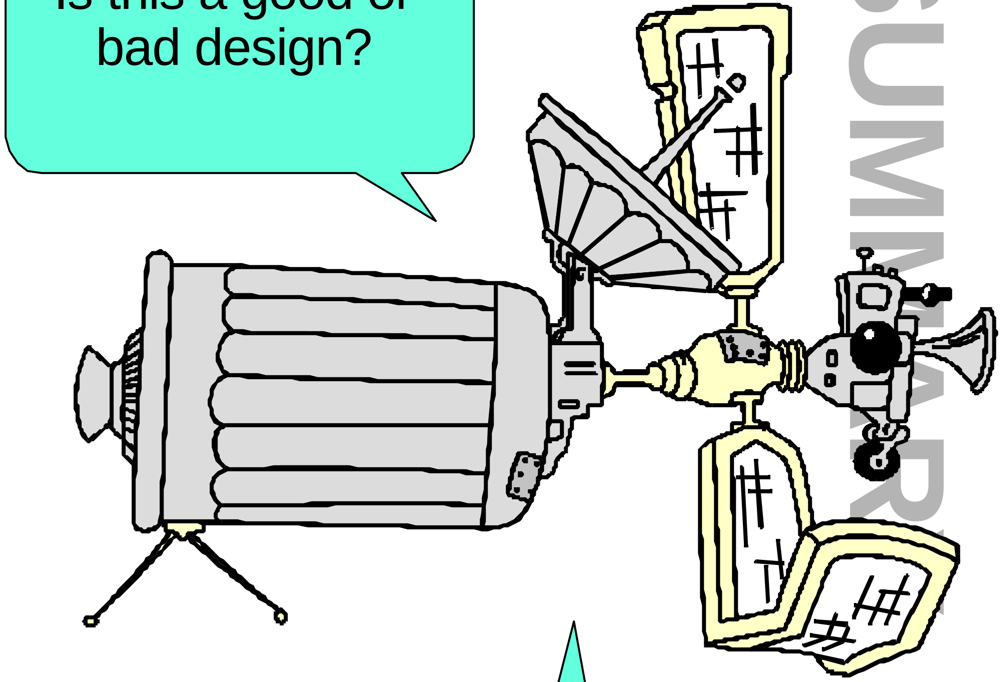
“Any time you depart from established practice, you make ten times the effort, ten times the investigation. Especially on a very large project.”

LeMessuier

And FINALLY...

- **The IGSMethod can be used to produce designs that work**
- **BUT...**
  - It is no substitute for experience
  - It must be used in a sensible manner
  - It must be part of an overall process

Is this a good or bad design?



It depends!

SUMMARY

DB Locations

- **ESE / IGSMethods Web URL**
  - http://method.ibm.com/Mweb/MethodR3.nsf/IBM+Global+Services+Method?OpenView

SUMMARY

Revision History

- 29/9/00 TL: added page numbering, updated content & logo for IGSMR3
- 15/1/01 IC: adjusted to reflect EMEA experiences. Addition of "material on "what is Architecture Thinking?"
- 19/1/01 TL: altered setup for printing to provide FILE name