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A Tool for Managing Software Architecture Knowledge


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Architecture Knowledge Management Issues

- Unavailability of architecture design knowledge
 - System evolution becomes hard
 - Difficult to identify design errors
- Use of COTS without fully understanding the assumptions
- Situation is worst in case of FLOSS components
- Lack of support in terms of practices and tools
 - What types of architecture knowledge are useful?
 - How to store and manage the knowledge?
 - Make knowledge capture cost-effective



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Capturing architecture knowledge



- An architecture embodies crucial design decisions
 - Rarely captured in architecture docs (if they exist!)
- If rationale behind design decisions is lost:
 - System evolution becomes hard
 - Difficult to identify design errors
- We did a survey:
 - 80% can't understand designs without adequate docs
 - 73% forget why they designed something!
 - Impediments to capturing design info:
 - 61% have no time/budget/tools
- And built an architecture knowledge management tool - BRedB



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Tool for Managing Architecture Knowledge



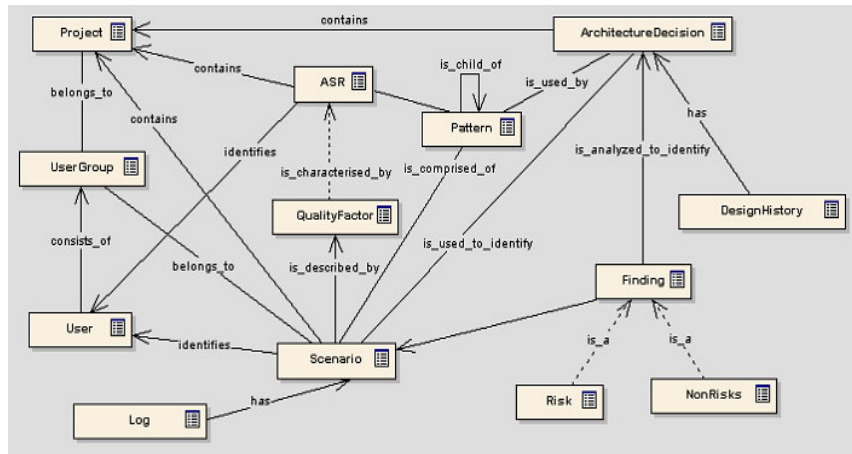
- **PAKME: A Process-based Software Architecture Knowledge Management Infrastructure**
 - A model of architecture knowledge management
 - Templates for capturing and structuring architecture knowledge
 - Repository of architectural knowledge and experiences
 - Resource for software architects
 - Source of adaptive software architecture processes
 - Support for owning technical and process knowledge

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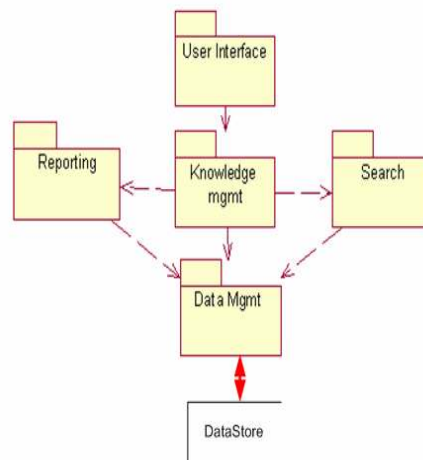
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A partial model of Architecture Knowledge



Component View of PAKME Architecture

- User Interface
- Knowledge Management
- Knowledge Search
- Reporting
- Data Management
- Knowledge Repositories



GUI for Start Using BRedB



Start Collaborative Tools Contact Management Project Management Content Production Corporate Library Project Collaboration Configuration

► Home | Knowledge-Based | Project-Based | Search

Project Collaboration

Knowledge Based

The knowledge-based involves capturing various experience artefacts that users may *create, modify, delete* and *search*. These artefacts include the following:

- General Scenarios
- Patterns
- Analysis Model
- Architecturally Significant Requirement

Project-Based

The project-based involves building database of artefacts for specific projects to support their software architecture evaluation. This can be achieved through creating new artefacts and/or extracting them from the knowledge-based. All newly created artefacts will be added to the knowledge repository. The project-based artefacts include:

- General Scenario
- Concrete Scenario
- Architecturally Significant Requirement
- Quality Factor
- Architecture Decision
- Alternative Decision
- Finding

Search

Search provides essential functionalities to allow users to seek for their desired artefacts. The two different types of search are:

- Field-based
- Keyword-based

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Support for Architecture Design



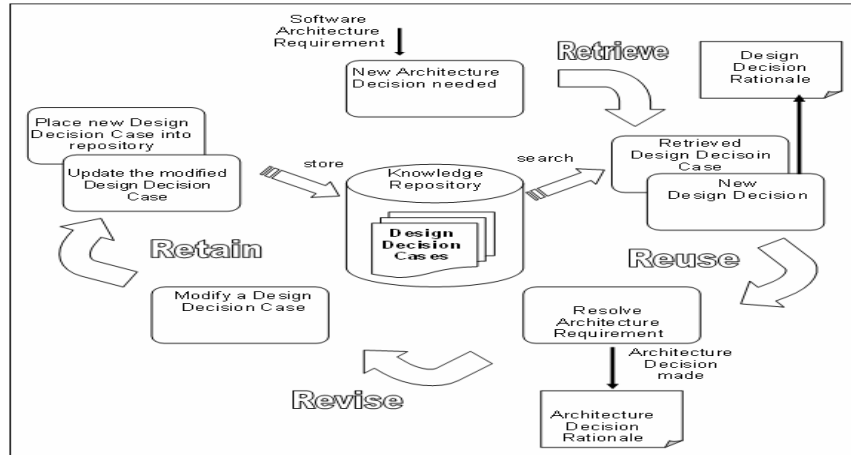
- Support for case-based reasoning by human expert
- Repository of reusable architectural artifacts
- Capture/access rationale for design decisions
- Catalogue of architecture and design patterns/tactics
- Search architectural artifacts and knowledge

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Capturing and Reusing Cases of Design Decisions



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Design Decision Captured as a Case



hipergate :: View Design Option - Database Server - Microsoft Internet Explorer

Rationale	View Design Option Rationale			
Used in Architecture Decision	Architecture Name	Description	Project Name	Project Domain
	High Server Performance	Require fast response times from the server. [more...]	BCS Project	research
Inspiration	This design, "Database Server", was inspired by the following Design Options: [Find more Inspiration...]			
	Design Option	Description		
	Secondary Server System	A Secondary Server is installed onto the system to help share the workload. Not only will this help improve the efficiency, but if the primary server failed, then the secondary server can continue the service. [more...]		
	Backup Server System	Introduce an extra server as backup. The extra server will be connected into the system but will only run when the primary server has failed. Hence users would not feel a lost in service. [more...]		
Inspired other Design Options	This design, "Database Server", inspired the following Design Options:			
	Design Option	Description		
	Multiple Server System	Introduce different servers to provide different services for the client. Hence would greatly reduce the workload the current servers. [more...]		
Modify	Modify current Design Option			

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Searching Design Decision Cases



hipergate :: Attach Design Option - Microsoft Internet Explorer provided by Desktop Services, I. T. Division

Design Option Search and Listing for Web Tier

Search Criteria:

Keywords to Search for: Performance
 or: scalability
 or: Through put

Application Type: finance
 Project Domain: Enterprise JavaBeans System
 Design Option is: Used, Considered

Display Result Sort by: Application Type Domain
 All Design Options (unsorted)
 Unused Design Options (only)
 Percentage Match

The following Design Options are currently in use:

Design Option	Description	Count	Project	Domain	Match %	Actions
Database Server	Introduce a dedicated server as a database service provider. This reduces the workloads on other systems and offers a centralized database. [more...]	1	BCS Project	research	100 %	Modify
Application Server	Have a dedicated Application Server to provide application service to the clients. Hence reduces the workload to other parts of the system. [more...]	0	None	None	100 %	Modify
Multiple Server System	Introduce different servers to provide different services for the client. Hence would greatly reduce the workload the current servers. [more...]	0	None	None	100 %	Modify

[List all Design Options](#) OR [Add New Design Options](#)

Refresh OK

*Delete function will only remove the Design Option from the considered list, not from knowledge database.

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Using a Design Decision Case



hipergate :: Design Option Listing - Microsoft Internet Explorer

Design Option Search and Listing for Web Tier

Search Criteria:

Keywords to Search for:
 OR
 OR

Display Results and Sort by: All Design Options

The following Design Options are currently in use:

Design Option Name	Description	Count	Project	Domain	Match %	Actions
Database Server	Introduce a dedicated server as a database service provider. This reduces the workloads on other systems and offers a centralized database. [more...]	1	BCS Project	research	100 %	Modify
Application Server	Have a dedicated Application Server to provide application service to the clients. Hence reduces the workload to other parts of the system. [more...]	0	None	None	100 %	Modify
Multiple Server System	Introduce different servers to provide different services for the client. Hence would greatly reduce the workload the current servers. [more...]	0	None	None	100 %	Modify

Number of Results found from search: 15

Attach Cancel

Multiple Backup	To allow multiple clients to backup certain parts of the system.					Modify Delete
Single Backup	To allow only one client to backup certain parts of the system.					Modify Delete
Client-Server Backup	A method that utilizes both the Client and Server to backup certain parts of the system. Hence, the data is distributed to multiple locations. [more...]					Modify Delete
Application Server	Have a dedicated Application Server to provide application service to the clients. Hence reduces the workload to other parts of the system. [more...]					Modify Delete

[List all Design Options](#)
[Add New Design Options](#)

Refresh OK

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Navigating the Knowledge Base



The screenshot shows the hipergate web application interface. On the left, there are search filters for 'Advanced Search' and 'Patterns'. The main area displays search results for 'Business Delegate'. A red arrow points from the search results to a detailed view of the 'Business Delegate' pattern.

Name	Description
Business Delegate	This pattern reduces coupling between tiers and provides an entry point for accessing the services that are provided by another tier. It may also provide results caching for common requests to improve performance. It typically uses a Service Locator to locate a service.
Context	In a distributed system, clients may be exposed to the complexity of dealing with the distributed components that provide services.
Problem	Presentation-tier components interact directly with business services, which exposes the implementation details of the services to the clients. Such a direct interaction makes the clients vulnerable to any changes in the business services.
Solution	Use Business Delegate to reduce coupling between presentation-tier clients and business services. The Business Delegate hides the underlying implementation details of the business service.
Parent	No Parent Available
Forces	1) Business Service
Tactics	1) Delegate Proxy 2) Delegate Adapter
Affected Attributes	Positively 1) Performance Negatively 1) Complexity 2) Introduce new layer
General Scenario	1) BD-S6 2) BD-S2
Usage Examples	1) E-Commerce

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Template for Capturing and Representing Patterns



The screenshot shows the 'View Pattern' template for the 'Business Delegate' pattern. The template is displayed in a table format with various fields and their corresponding values.

Name	Description
Business Delegate	This pattern reduces coupling between tiers and provides an entry point for accessing the services that are provided by another tier. It may also provide results caching for common requests to improve performance. It typically uses a Service Locator to locate a service.
Context	In a distributed system, clients may be exposed to the complexity of dealing with the distributed components that provide services.
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Forces	1) Business Service
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Usage Examples	1) E-Commerce

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Support for Architecture Documentation



- Templates for documenting design decisions
- Store architectural models and documents
- Support for standards such as IEEE 1471-2000
- Represent architectural decisions using views
- Attach process knowledge to architectural artifacts

Structuring and Representing Architecture Decisions



hipergate :: View Architecture Decision - Business Component Tier - Microsoft Internet Explorer ...

View Architecture Decision				
Name	Business Component Tier			
Concrete Scenario	Changes to the platform occur			
Quality Factor	Modifiability			
Description	The business components constitute the core business logic for the application. The business components are realized by Enterprise JavaBeans, the software component model supported by J2EE.			
Comment	This frees the application programmer from cluttering the business logic with code to handle system and environmental issues.			
Architecture Description	Functions/processes are divided between clients and server.			
Contractor	NICTA			
Compliant	Complied			
Ranking	5			
Decision Considered	JAVA Enterprise Design			
Architecture Decision	Present Rationale			
	Date	Time	Decision Name	View Rationale
	2006-12-24	13:23:55	JAVA Enterprise Design	[detail...]
Design History	Past Rationales			
	Date	Time	Decision Name	View Rationale

Modifying an Architecture Decisions



hipergate :: Edit Architecture Decision - Compliance with the High Level Architecture (HLA) - MI...

Edit Architecture Decision

Name Compliance with the High Level... +

Concrete Scenario Reconfigure Wargame 2000

Quality Factor Reconfigurability

Description The HLA was developed under the leadership of the Defense Modeling and Simulation Office (DMSO) to support reuse and interoperability across the large numbers of different types of simulations developed and maintained by the DoD. +**

Comment HLA compliance in Wargame 2000 is achieved via an HLA gateway to interface with other systems that are HLA compliant. +**

Architecture Description Functions/processes are divided between clients and server. +

Contractor NICTA

Compliant Complied

Ranking No ranking entered

Chosen Design Option Provide a virtual gaming site

Select Design Option Provide a virtual gaming site

Attach Design Option [View/Attach More Design Options](#)

Attached Documents (Please add documents.) [Add Documents](#)

Architecture Relationship (Please add relationships.) [Add Architecture Relationships](#)

Keyword (Please add keywords.) [Add Keywords](#)

[Save](#) [Cancel](#)

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Modifying a Pattern



hipergate :: Edit Pattern - Microsoft Internet Explorer

Edit Pattern

Name Value Object +

Type Design pattern * (create Pattern Type if none)

Description This pattern provides best techniques and strategies to exchange data across tiers. It attempts to reduce the network overhead by minimizing the number of network calls to get data from the business tier. +**

Context Application clients need to exchange data with components residing on multiple tiers. Usually data is exchanged with enterprise beans. +**

Problem A client object has to make multiple calls to a business object's method to obtain all the attribute values. Calls are usually remote, which causes network overhead and degraded performance. +**

Solution Use a value object to encapsulate the business data, which can be sent to and obtained from enterprise bean in a single call. The value object is constructed, populated, and passed to the clients by the bean. +**

Child of

Forces (Please add factors affecting the problem and solution.) [Add Forces](#)

Available Tactics (Please add tactics which are used to implement the solution.) [Add Tactics](#)

Affected ASR [Add Positively Affected](#) [Add Negatively Affected](#)

General Scenario (Please add supported general scenarios.) [Add Supported General Scenario](#)

Usage Examples (Please add examples of usage to solve the problem.) [Add Usage Example](#)

Keywords (Please add keywords.) [Add Keywords](#)

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Support for Architecture Evaluation



- Repository of general scenario to support QAWs
- Capture rationale and contextual information surrounding design decisions
- Search and view rationale for previous design decisions
- Documenting findings of evaluating design decisions
- Categorize findings in suitable risk themes
- Generate evaluation reports for the management

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General Scenario Captured in BRedB



General Scenario Listing

[New](#) [Delete](#) [Accept](#) [Reject](#) [Home](#) [Search](#) [Discard](#) [Close](#) [Go](#) [Results](#)

Proposed General Scenarios

[Previous](#)

Scenario Name	Description	Source	Date Entered	Logs
SC0-1	QVD shall protect online payments for the services that means the transactions between the QVD and financial institutions must be protected.	User-Defined	Sun 24 Dec 2006 19:47	
SC0-2	QVB provides secured storage to customer's credit details and other information.	User-Defined	Sun 24 Dec 2006 19:47	
SC0-3	QVD shall be able to identify different users and verify their access privileges according to their membership of different User groups.	User-Defined	Sun 24 Dec 2006 19:48	
SC0-4	QVB shall be able to detect and prevent Denial Of Service (DOS) attacks. The system shall be able to run available most of the time.	User-Defined	Sun 24 Dec 2006 19:49	
SC0-5	QVB is an web-based system that shall be easily modifiable to introduce changes in the security policy and other security checks.	User-Defined	Sun 24 Dec 2006 19:50	

Accepted General Scenarios

[Previous](#)

Scenario Name	Description	Source	Date Entered	Logs
Performance	Require bounded response time and/or certain system throughput.	User-Defined	Tue 18 Dec 2006 11:20	
Change the hardware platform	Change physical location of service with minimal impact on the rest of the system.	Pattern	Tue 19 Dec 2006 10:23	
Change number of users	Number of users changes while maintaining other qualities such as performance.	Pattern	Tue 19 Dec 2006 10:30	
Change the implementation	Implementation details change without affecting much of the rest of the system.	Pattern	Tue 19 Dec 2006 11:43	
Addition of functionality	Addition of functionality without impacting the rest of the system.	Pattern	Tue 19 Dec 2006 11:43	
Availability	An internal or external component fails and the system is able to recognize the failure and has strategies to compensate for the fault.	Pattern	Tue 19 Dec 2006 12:04	
Not a service user	An event arrives at the system for which it was not prepared.	User-Defined	Tue 18 Dec 2006 15:20	
Q	Q	User-Defined	Tue 11 Dec 2006 10:12	

Rejected General Scenarios

[Previous](#)

Scenario Name	Description	Source	Date Entered	Logs
SC0-5	Changes in the business services implementation shall not require corresponding changes in their clients residing in other tier.	User-Defined	Fri 26 Jan 2007 11:02	
SC0-6	Pre-processor components shall not be exposed to the implementation details of the business services they use.	Pattern	Fri 26 Jan 2007 11:07	
SC0-6	Different clients, such as web clients, web clients, and thick clients need access to business services.	Pattern	Fri 26 Jan 2007 11:10	
SC0-6	Services calls across network tiers shall be minimized to avoid degraded performance.	Pattern	Fri 26 Jan 2007 11:02	

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Utility Tree of Concrete Scenarios



The screenshot shows two windows from the hipergate application. The left window, titled "hipergate :: Utility Tree for BCS Project - Mo...", displays a tree structure under "Utility Tree for BCS Project". The tree is expanded to show "Performance" > "Response [time<1 second]". An arrow points from this node to the right window.

The right window, titled "hipergate :: View Concrete Scenario - Int...", displays the details for a selected scenario:

Name	Internode message transfer
Description	Internode message transfer completes < 1 second
Quality Factor	Response [time<1 second]
Complexity Level	High
Importance	Medium

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Viewing Details about a Concrete Scenario



The screenshot shows the "View Concrete Scenario" dialog box in Microsoft Internet Explorer. It contains a table with the following data:

Name	Run simulations with debug enabled.				
Description	Run simulations with debug enabled.				
Quality Factor	Meet real-time requirements				
Complexity Level	Low(Default)				
Importance	Low(Default)				
Context					
Stimulus					
Response					
Source of Stimulus					
Date Proposed	Tue 19 Dec 2006 16:42				
Status	Proposed				
User	Administrator				
General Scenario					
Analysis Model					
Classification	Unclassified(Default)				
References					
Documents	<table border="1"> <thead> <tr> <th>Name</th> <th>Created By</th> </tr> </thead> <tbody> <tr> <td>AnalyzingEnterpriseJavaBeans.pdf</td> <td>Administrator</td> </tr> </tbody> </table>	Name	Created By	AnalyzingEnterpriseJavaBeans.pdf	Administrator
Name	Created By				
AnalyzingEnterpriseJavaBeans.pdf	Administrator				
Tactics	1) Tag View Management Strategy				
Findings	No Finding Associated				

Buttons: Edit, Cancel

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Documenting and Viewing Findings



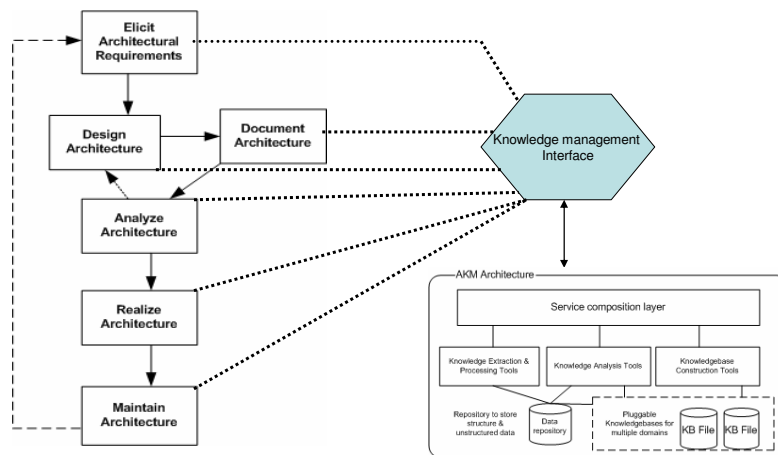
The screenshots show the hipergate application interface for finding management. The 'New Finding' window includes fields for Concrete Scenario (BCS), Architecture Decision (ABCS), Chosen Design Option (B), Description, Complied (Not Complied), and Ranking (No ranking entered). The 'Edit Finding' window shows the same fields with updated values: Description (BCS-ABCS-B-F), Complied (Not Complied), and Ranking (5). It also features sections for 'Attach Documents' and 'Risks/Non-Risks' with associated buttons.

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Support for Architecture-Centric Development



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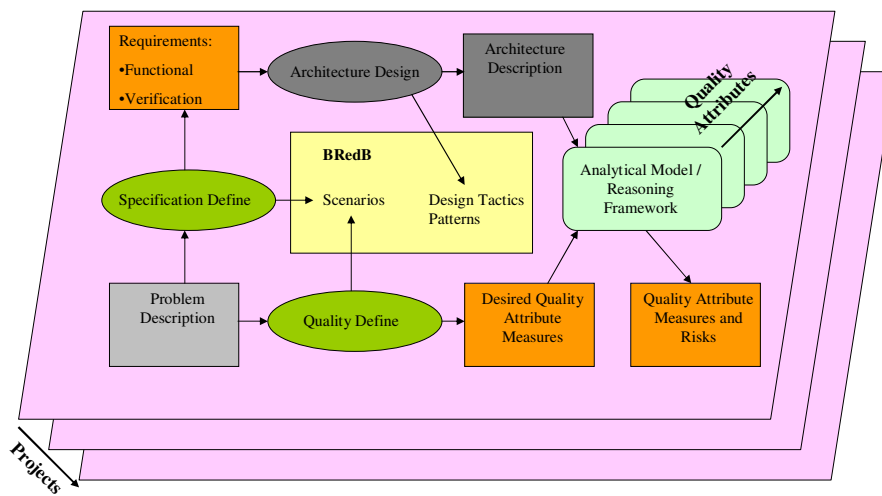
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BRedB Case Study

- Australian Defense Science Technology Organization (DSTO)
 - Avionics architecture assessment
 - Long lived, high cost projects
- BRedB used for avionic architecture evaluation
 - Quality attributes
 - Evaluation framework
 - Risk management



BRedB Supported Architecture Evaluation Process



Initial Findings



- BRedB added considerable rigour to the DSTO evaluation process
 - Repository of expert knowledge in general scenarios
 - Archive of past project experience valuable over time
 - effective mechanism to organise and query large amounts of architecture knowledge
- BRedB should be useful if you:
 - are outsourcing/off-shoring/purchasing your systems?
 - have superhero architects prone to sudden departure or large pay increase demands
- More studies and R&D needed
 - We're keen to work with interested partners ...



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Conclusion and Future work



- Software architecting is receiving significant attention – several methodologies proposed and promoted but little attention on managing architectural knowledge
- Limited reusability of architectural artefacts.
- We have identified/developed techniques to provide knowledge management support for architecting
- PAKME – Supports the knowledge management tasks
- Future work includes:
 - Contextual search for retrieving task-related information
 - Converting PAKME into Eclipse plug-in
 - Assessing the value of PAKME through more industrial trials

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