B401 Solution Architecture Overview

Provincial Government of the Western Cape (PGWC)

Medical Emergency Transport and Rescue Organisation (METRO)

Emergency Medical Services (EMS)

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Document History

Revision History

Revision Number	Revision Date	Summary of Changes	Changes marked
1.1	2010-01-28	Final version	No

Approvals

This document requires following approvals.

Name	Title
Dr. Cleeve Robertson	Director – Emergency Medical Services

Distribution

This is the intended distribution list for this document:

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1. Introduction

This chapter identifies the document and the business to which it relates, describes the contents of the document, and states its purpose.

1.1 Identification

This document describes the architecture components required to implement the solution for the Emergency Medical Services (EMS) application features [1], Non-Functional Requirements [2] and Information Requirements [3] It is presented as a Solution Architecture Overview following the Enterprise Architecture method. This Project is a Requirements Specification Phase for Provincial Government of the Western Cape (PGWC) METRO EMS in preparation for a Tender for Services.

1.2 Document Context
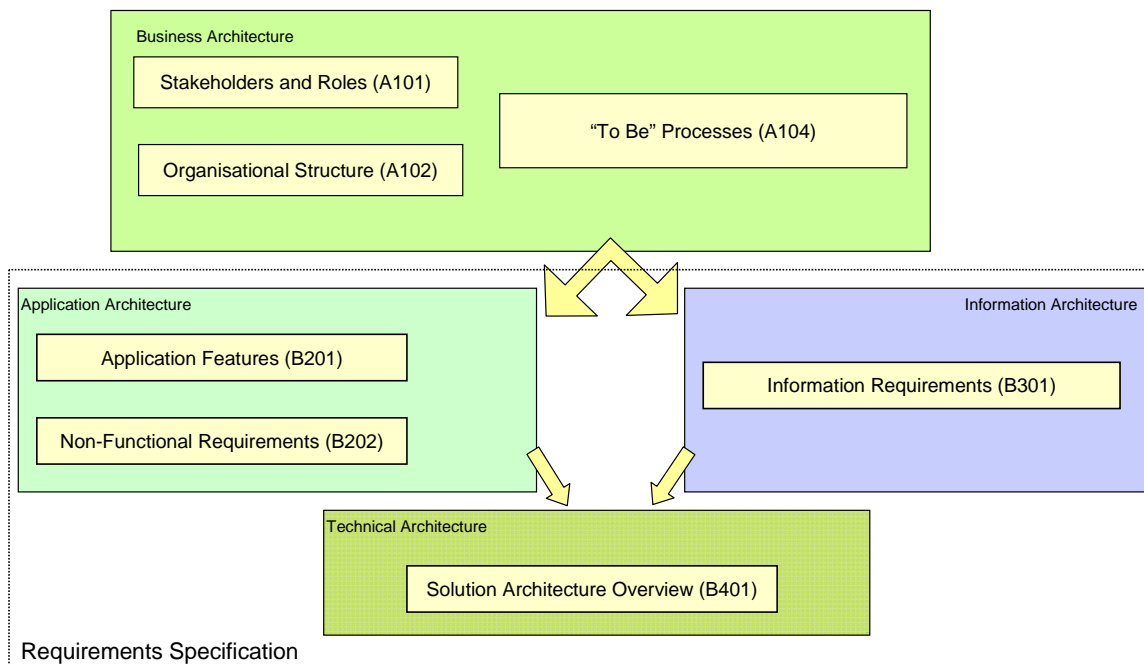
1.3 Document Description

The Solution Architecture (SA) incorporates relevant "Application" and "Technology" components of the Enterprise Architecture. A SA identifies and defines technology infrastructure, principles, policies and standards required to support the organisation's processes, information resources and applications.

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1.4 Purpose

This Solution Architecture Overview document is used:

- To provide a contextual technology framework and diagrams that will underpin the desired application solution.

- To specify architecture principles and standards, based on best practice, that apply to the technology components within the framework

1.5 References

This document is based on and refers to the following documents:

[1]   B201 Features v1.1

[2]   B202 Non-Functional Requirements v1.1

[3]   B301 Information Requirements v1.1

        These are found in the same document location as this document.

        Additional external references include:

[4]   IT Infrastructure Library® (ITIL) Version 2 - UK Office of Government Commerce

[5]   IT Infrastructure Library® (ITIL) Version 3 - UK Office of Government Commerce

[6]   COBIT® – The IT Governance Institute®

[7]   ISO 27000 – 2005 Series – International Organisation for Standardisation

[8]   British Standards Institution (BSI)

[9]   TOGAF Version 9 - The Open Group Architecture Framework (TOGAF) - The Open Group

[10]   "SOA in any economic climate" - Zapthink –– May 2008

[11]   "A Revolution in Agility: Business Integration through Service-Oriented Architecture"
        An Oracle White Paper – updated August 2008

[12]   "Key Components of SOA" by: Mike Rosen, Editorial Director, SOAInstitute.org - Tuesday July 18, 2006

[13]   "Establishing a Culture of Measurement – A Practical Guide to BI" – White Paper by Information Builders

[14]   Magic Quadrant for Business Intelligence Platforms - 16 January 2009
        James Richardson, Kurt Schlegel, Rita L. Sallam, Bill Hostmann
        Gartner RAS Core Research Note G00163529

[15]   Wikipedia, the free encyclopaedia

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2. Target Solution Architecture

2.1 Context

Enterprise Architecture is the practice of applying a comprehensive and rigorous method for describing a current and/or future structure and behaviour for an organisation's processes, *information systems (solutions)*, personnel and organisational sub-units, so that they align with the organisation's core goals and strategic direction.

The following sections lay out the solutions architecture requirements that will be used to guide the selection of an EMS solution according to best practices. Various best practice frameworks and industry standards are referenced throughout this document and are included in the list of references in section 1.5 above.**Error! Reference source not found.**

An overview of the document follows:

Context	*Enterprise Architecture, Solution Architecture, Best Practice*
General Architecture Principles/ Qualities	*Pervasive principles that apply across the Solution architecture*
Communications Architecture	*High-level Business View, Network Topology, Telephony, Communications – Switch and ECC to Vehicle*
Continuity and Availability	*Minimise risk to emergency services in the case of failure of the IT infrastructure*
Application Architecture	*Service-oriented Architecture Services Reporting*
Annexures	*A: TOGAF TRM B: SOA Concepts C: Glossary of Terms*

Figure 1: Overview of Document Structure

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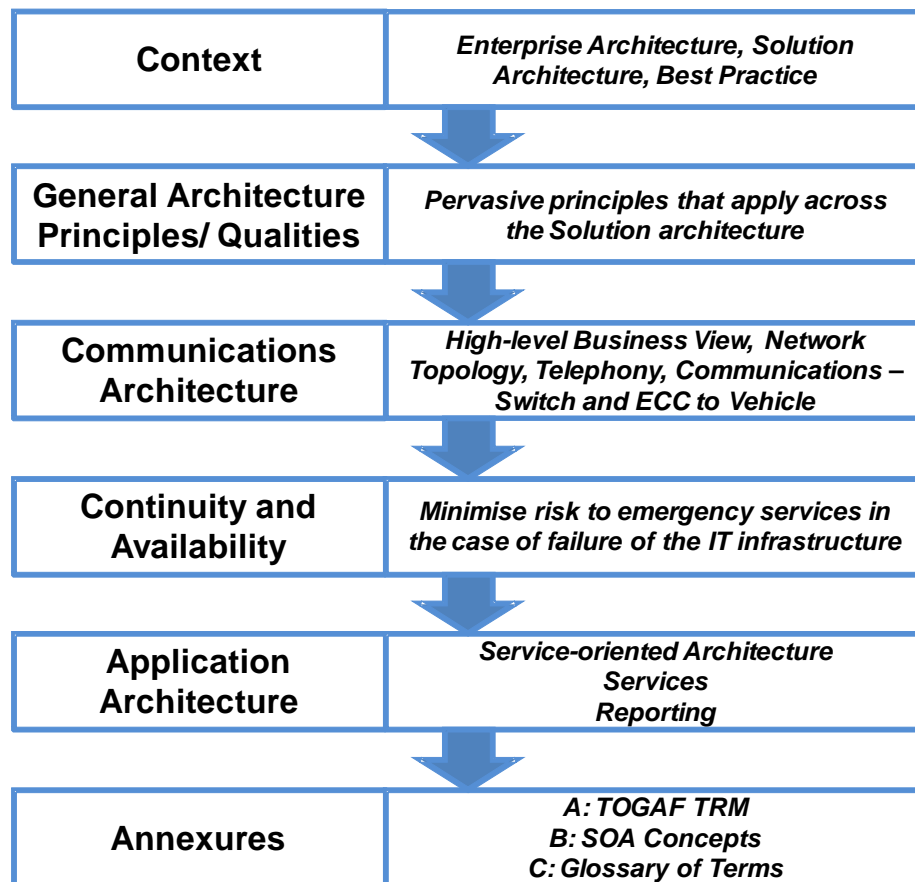Version: 1.1
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2.2 General Architecture Principles

Document B202 [2] reflects a number of non-functional requirements that are in fact architecture principles that will be used to guide the selection of the EMS solution. TOGAF's TRM [9] incorporates a set of *pervasive* "attributes or qualities" that are applicable across all service components of the solution architecture, and these serve to reinforce the equivalent non-functional requirements in [2]. For example, for the management service to be effective, manageability must be a pervasive quality of all platform services, applications, and Communications Infrastructure services.

The service qualities presently identified in the TRM taxonomy are:

- **Availability** (the degree to which something is available for use), including:
  - **Manageability**, the ability to gather information about the state of something and to control it
  - **Serviceability**, the ability to identify problems and take corrective action, such as to repair or upgrade a component in a running system
  - **Performance**, the ability of a component to perform its tasks in an appropriate time
  - **Reliability**, or resistance to failure
  - **Recoverability**, or the ability to restore a system to a working state after an interruption
  - **Locatability**, the ability of a system to be found when needed

- **Assurance**, including:
  - **Security**, or the protection of information from unauthorised access
  - **Integrity**, or the assurance that data has not been corrupted
  - **Credibility**, or the level of trust in the integrity of the system and its data

- **Usability**, or ease-of-operation by users, including:
  - **International Operation**, including multi-lingual and multi-cultural abilities

- **Adaptability**, including:
  - **Interoperability**, whether within or outside the organisation (for instance, interoperability of calendaring or scheduling functions may be key to the usefulness of a system)
  - **Scalability**, the ability of a component to grow or shrink its performance or capacity appropriately to the demands of the environment in which it operates
  - **Portability**, of data, people, applications, and components
  - **Extensibility**, or the ability to accept new functionality
  - **New paradigm adaptability,** e.g. the ability to accommodate new services such as object-orientation and service-orientation

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2.3 Communications Architecture

The Communications Architecture contains the hardware and software elements which make up the networking and physical communication links used by a system, and of course all the other systems connected to the network. It deals with the complex world of networks and the physical Communications Infrastructure, including switches, service providers, and the physical transmission media.
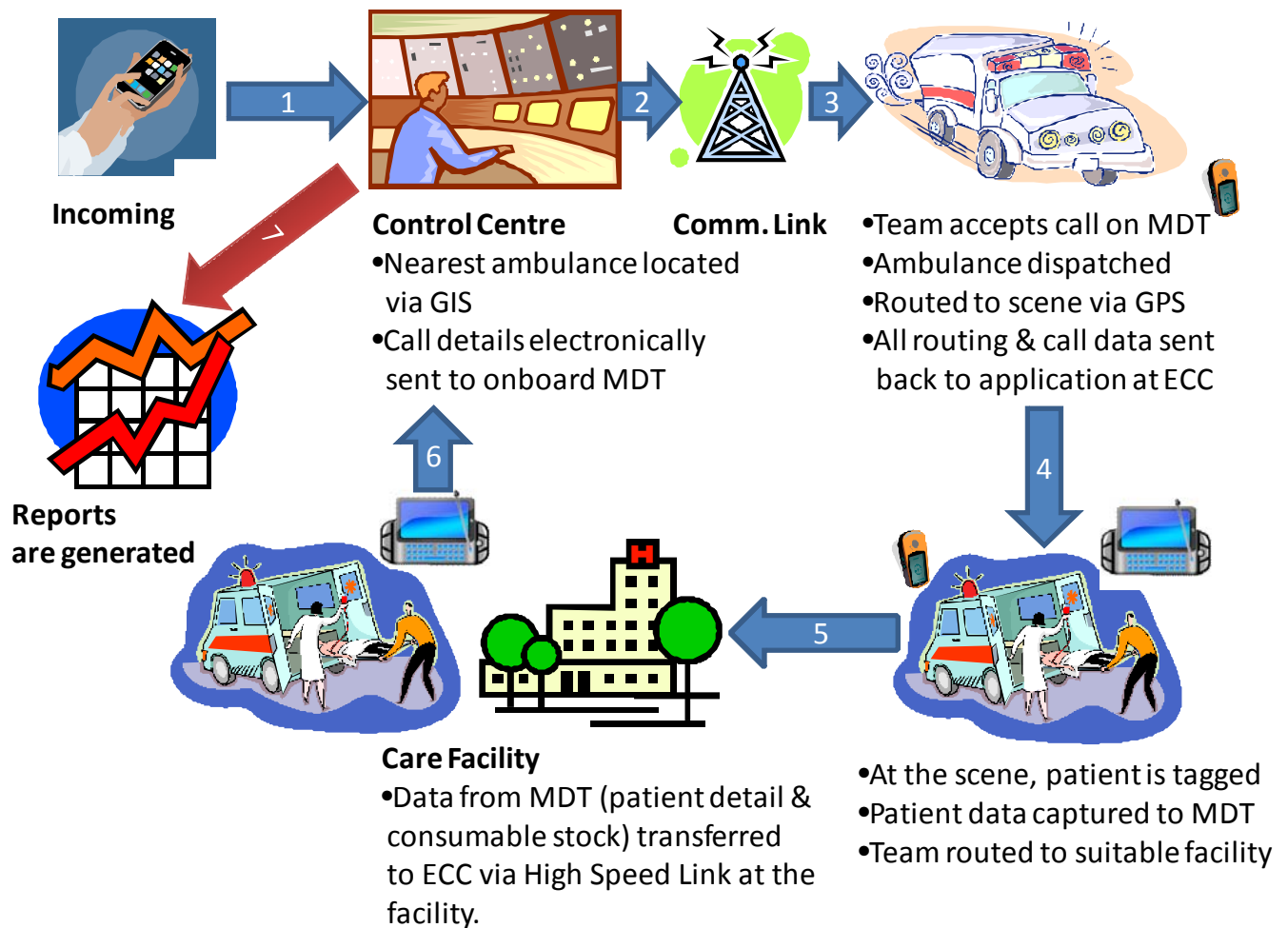
2.3.1 High-level Business View

Incoming

Control Centre
• Nearest ambulance located via GIS
• Call details electronically sent to onboard MDT

Comm. Link

• Team accepts call on MDT
• Ambulance dispatched
• Routed to scene via GPS
• All routing & call data sent back to application at ECC

Reports are generated

Care Facility
• Data from MDT (patient detail & consumable stock) transferred to ECC via High Speed Link at the facility.

• At the scene, patient is tagged
• Patient data captured to MDT
• Team routed to suitable facility

Figure 2: Business View of Communications

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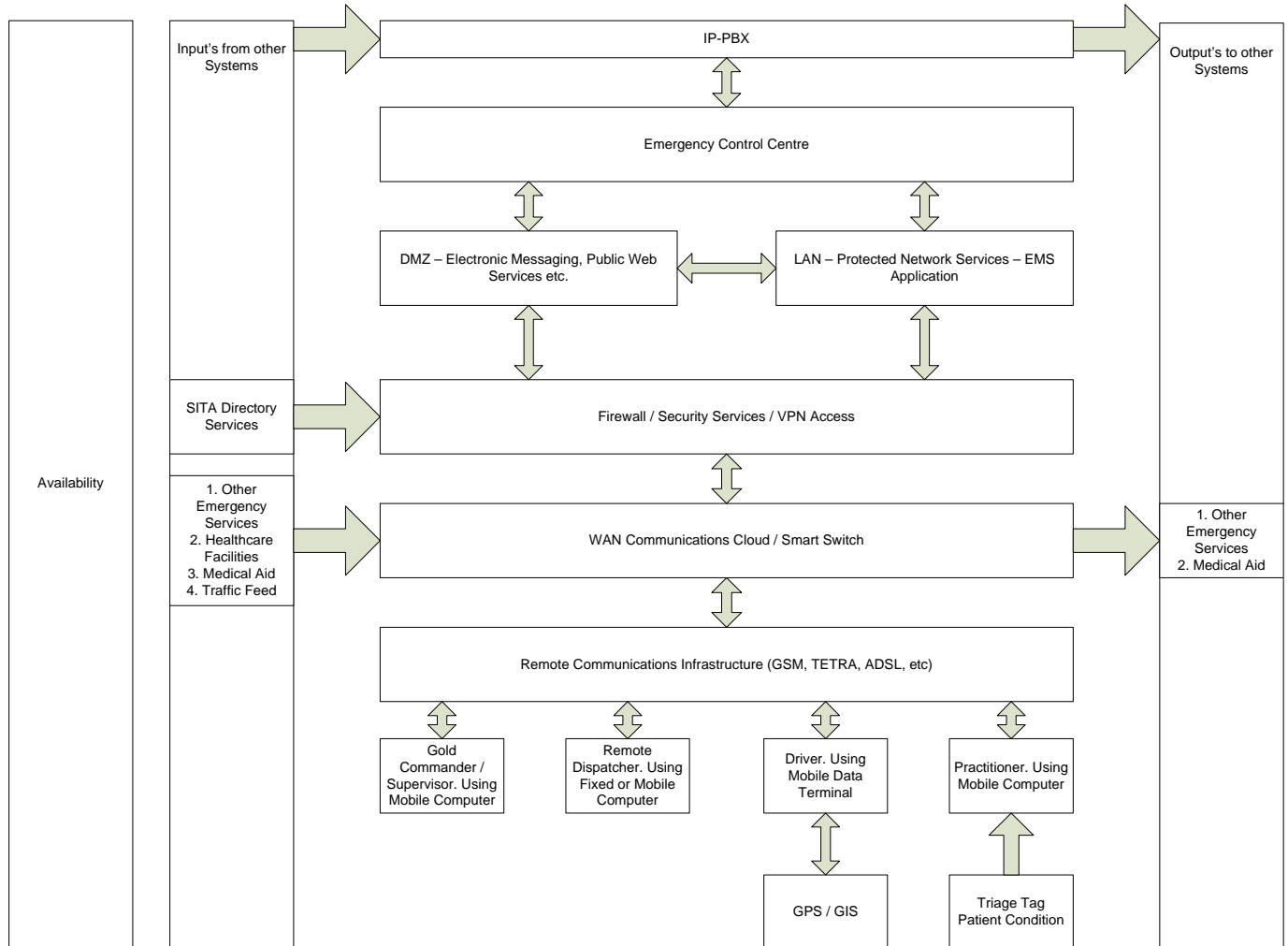## 2.3.2 Network Topology – Architectural View

Figure 3: Integration - Technology Architecture

The diagram above illustrates the core elements of integration to be considered. The proposed solution will need to interact with various other outside systems and networks, These other systems and networks are not necessarily under the control of EMS, and the system will need to function as part of the SITA network.

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2.3.3 Telephony System

EMS requires flexible, scalable, highly available and resilient, cost effective PBX's at each centre.

The PBX should be IP based and must deliver enterprise class, unified communications as a business application for Service Oriented Architecture (SOA).

Ideally, the IP PBX is an enterprise software suite that runs on industry-standard servers across an existing data network without proprietary hardware. The system must scale to at least 5000 ports across any number of locations, provide seamless connectivity across these locations, and should achieve 99.9% reliability with no single point of failure. Locations must have the ability to operate autonomously in the case of a WAN interruption, and should recover automatically when the WAN service is restored. Alternative command centre switching must be aligned to availability requirements as stated in the Non-Functional document [2].

Industry standards based devices, gateways and other communications endpoints, should be supported, in order for EMS to avoid being locked in to a single solution provider.   The solution should support a platform-neutral and language-neutral set of development tools for flexible application development and integration. Access to the communications services available within the IP-PBX should be provided through standard XML and SOAP technology, such that third party application integration is possible. Ideally, the IP-PBX needs to be an enterprise software switch which aligns with the concepts of a Service Oriented Architecture (SOA) enabling enterprise applications to easily embed communications functions into the business processes.

The IP-PBX software should be at the core, and support a wide range of industry standard system components and services. It must support convergence of high quality voice, text messaging, video conferencing, unified e-mail and voicemail messaging, presence, mobility, advanced call forwarding, and calendar integration, as well as other converged applications in the SOA platform. Integration with enterprise applications is required such that customised solutions are possible.

The IP-PBX should have a presence engine that allows users to view the presence state of other users so that an appropriate means of communication can be chosen. Also, the device must have the ability to find, or intelligently route calls to a user based on a number of criteria including presence state, time of day and caller line identification. Mobile and remote workers should be able to be connected to the system as if they were in the office.

The system should be able to be deployed centrally or in a distributed environment.

The features to be supported are defined in the features document [2].

2.3.4 Communications Switch

For efficient data communication from the Emergency Control Centre to the onboard equipment in the vehicles, as well as voice communication with the drivers and medical practitioners, a communications switch is required which will switch across different communications networks, paths and channels, based on a predefined business rule set.

The switch must deliver enterprise class, reliable communications as a business application for Service Oriented Architecture (SOA). The system needs to be scalable across any number of locations, provide seamless connectivity across these locations, and should achieve 99.9% reliability with no single point of failure. Locations must have the ability to operate autonomously in the case of a WAN interruption, and should recover automatically when the WAN service is restored.

The switch should support an industry standard set of development tools for flexible application development and integration. Access to the services available within the switch should be provided through standard XML and SOAP technology, such that third party application integration is possible. Ideally, the switch needs to align with the concepts of a Service Oriented Architecture (SOA) enabling enterprise applications to easily embed communications functions into the business processes.

EMS needs access to a switching system with the capability of integrating voice and data communications of all types in a command and control type environment such as an Emergency Control Centre (ECC). The switch should obviate the need for dispatchers to have multiple computers (one per function, e.g. radio, data, GIS). The system

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needs to include a full range of switching functions for telephony, radio circuits, trunked radio and telephone conferencing.

It should support a wide range of commercial voice terminals (analogue and digital), radios, wireless systems (such as IP-DECT), integrated voice communication terminals, assignable loudspeakers, and virtually any other analogue or digital voice source. The switching infrastructure must be able to bring all the types of voice and data communications needed by each user together in a voice and or data terminal.

The switching system must be capable of connecting to all types, brands and styles of first responder land-mobile radios in a fixed or mobile communications centre. The system will be the hub that connects or networks different types of radios (even radios on different frequency bands) and at the same time allows the local users at the communications centre to join multiple radio networks and communicate over radio and landlines at the same time.

The solution needs to cater for a range of analogue and digital radio and switching communications technologies, for example, GSM, TETRA, and IRIDIUM etc. The system will need to cater for image processing and announcement systems, both for voice and data transmission.

The switch must support store and forward technology – such that data is not lost between changes in communications technologies. It must also have the ability to block certain data streams and transmit data securely.

2.3.5 Communications – ECC to Vehicle

Onboard Communication:

The EMS vehicle driver needs to have access to portable devices such as a mobile data terminal (MDT) to liaise with the control centre. The mission critical MDT needs to be loaded with maps for navigation purposes and have a facility for the driver to communicate with the dispatcher via various status buttons.

Various protocols and Standard Operating Procedures need to be available on the MDT.

The EMS emergency care practitioner also needs to have access to portable devices such as a mobile data terminal (MDT) to liaise with the control centre. The client based MDT needs to interface with the control centre for data transfer. The emergency care practitioner needs to capture information about patients and incidents on the MDT and transfer the information to the control centre via the WAN.

The Mobile Data Terminal should be a vehicle mounted platform for the driver, and may be a portable unit for the medical practitioner. The units must be designed to withstand South African conditions and rural environments, temperature range, vibrations, enlarged and changing operating voltages, and reading precision of the display. The device should comply with IP65 standards for protection against dust and water.

The device must have a variety of optional wireless and wide area network modules for real-time communication and data capture.

Data from the practitioner's MDT should be stored for exchange with the control room system via a high speed link once the practitioner has completed the emergency call, unless this data is transferable via a mobile WAN link.

In Vehicle Control Units:

Vehicles may need In Vehicle Control Unit's to facilitate data transfer and routing / tracking information, as well as provide control functions to various components in the vehicle, e.g. disabling the vehicle sirens (by the dispatcher) in certain circumstances. Additionally, the control units may need to provide an interface to the system for RFID or barcode scanners, etc.

Uncomplicated integration of the control unit with the vehicle's electrics, radio and peripheral devices would be advantageous.

Required information should be transmitted to the control room as often as possible and preferably on a real time basis over the least cost route, be this via GSM, TETRA, etc.

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2.4 Continuity and Availability

The nature of the EMS business dictates that the service must be extremely resilient and absolutely recoverable at all times.

2.4.1 Business Continuity Management Overview

Business continuity management (BCM) is a process that establishes a fit-for-purpose strategic and operational framework that:

- Proactively improves an organisation's resilience against the disruption of its ability to achieve its key objectives;

- Provides a rehearsed method of restoring an organisation's ability to supply its key products and services to an agreed level within an agreed time after a disruption; and

- Delivers a proven capability to manage a business disruption and protect the organisation's reputation and brand.

A business continuity plan (BCP) includes planning for non-IT related aspects such as key personnel, facilities, crisis communication and reputation protection, and should refer to the disaster recovery plan (DRP) for IT related infrastructure recovery / continuity. See section 2.4.2

The basic principles and interactions between elements are as set out in the following diagram which highlights the various service agreements/contracts required between IT Service Providers and Users, and IT Service Providers and internal versus external suppliers and maintainers [4].
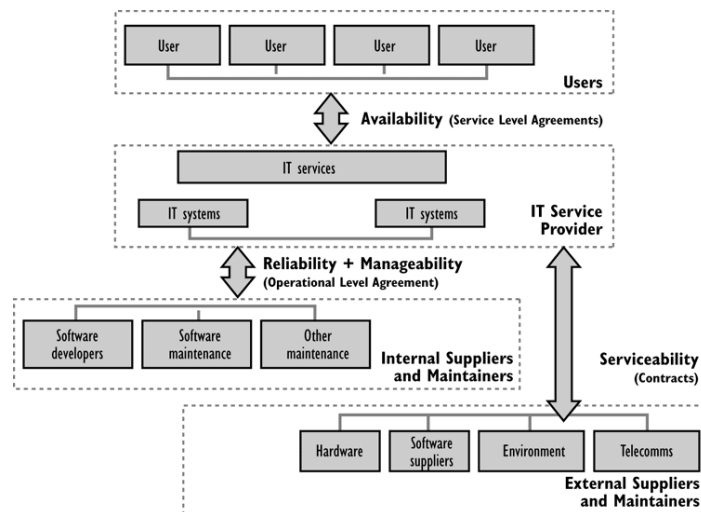

Figure 4: End to end service continuity within the core service

Elements of resilience to consider are as follows:

- **Data centre & data centre environmental equipment and controls** – Build to the Uptime Institute tier level III specifications for data centre environmental systems in support of high availability systems.

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- ***Platforms & Operating System availability and resilience*** – Virtualisation / clustering / failover
- ***Networks& communications*** – Redundant and alternative routing,
- ***Application availability*** – All applications required to support the service including those applications which provide information to and applications which require information from the service.
- ***Information availability*** – Database replication / database recovery / Backup and Restore considerations.
- ***Networks resilience and recoverability –*** Guidance is provided in figure 5**Error! Reference source not found.** below.
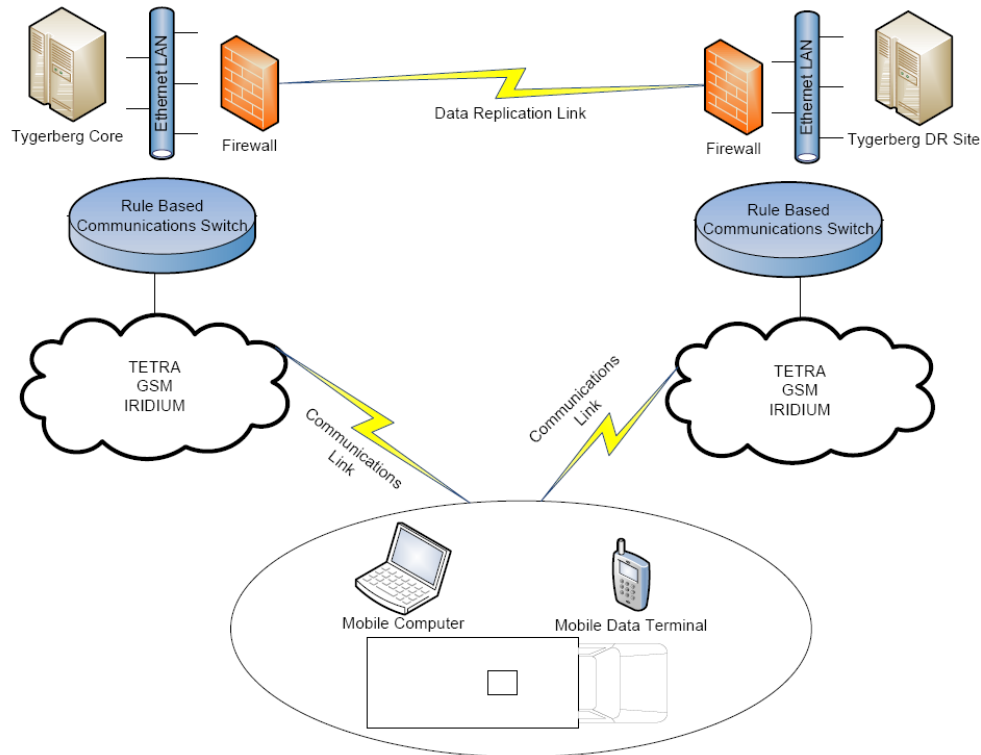

Figure 5: Sites and communications architecture

The core system is replicated to a remote site for the purposes of failover and business continuity in the event of system failure at the primary location. In the event of such failover, operations will not be interrupted and the units in the field will be automatically and seamlessly routed to the failover / recovery site.

2.4.2 Disaster Recovery Considerations

Disaster recovery is common term that refers to the process, policies and procedures related to preparing for recovery or continuation of **technology infrastructure** critical to an organisation after IT failure as a result of **natural or human-induced "disaster".**

Disaster recovery planning is a subset of the larger process known as business continuity planning and should include planning for resumption of applications, data, hardware, communications (such as networking) and other IT infrastructure.

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The core system must be redundant and recoverable at an alternative site within the required timeframe. Networks must automatically reroute to facilitate a relocation of the core. Access to the core and alternative site must be transparent to mobile sites and vehicles.

Ensuring that this is achievable within the constraints of the locality, geography and environment will require a considerable coordinated effort from all members within the consortium who design, develop, test, deploy and support the end to end solution or service over its useful life.

The solution which is considered as an end to end service needs to remain accessible and fully functional within the stated availability and performance thresholds in support of business needs.

The end to end solution or service must be resilient to single points of failure and recoverable within the performance and capacity requirements stated in the non functional requirements document [2]. The proposed technology architecture must meet these objectives. Elements of the network, site dispersion and interoperability are noted here for reference.
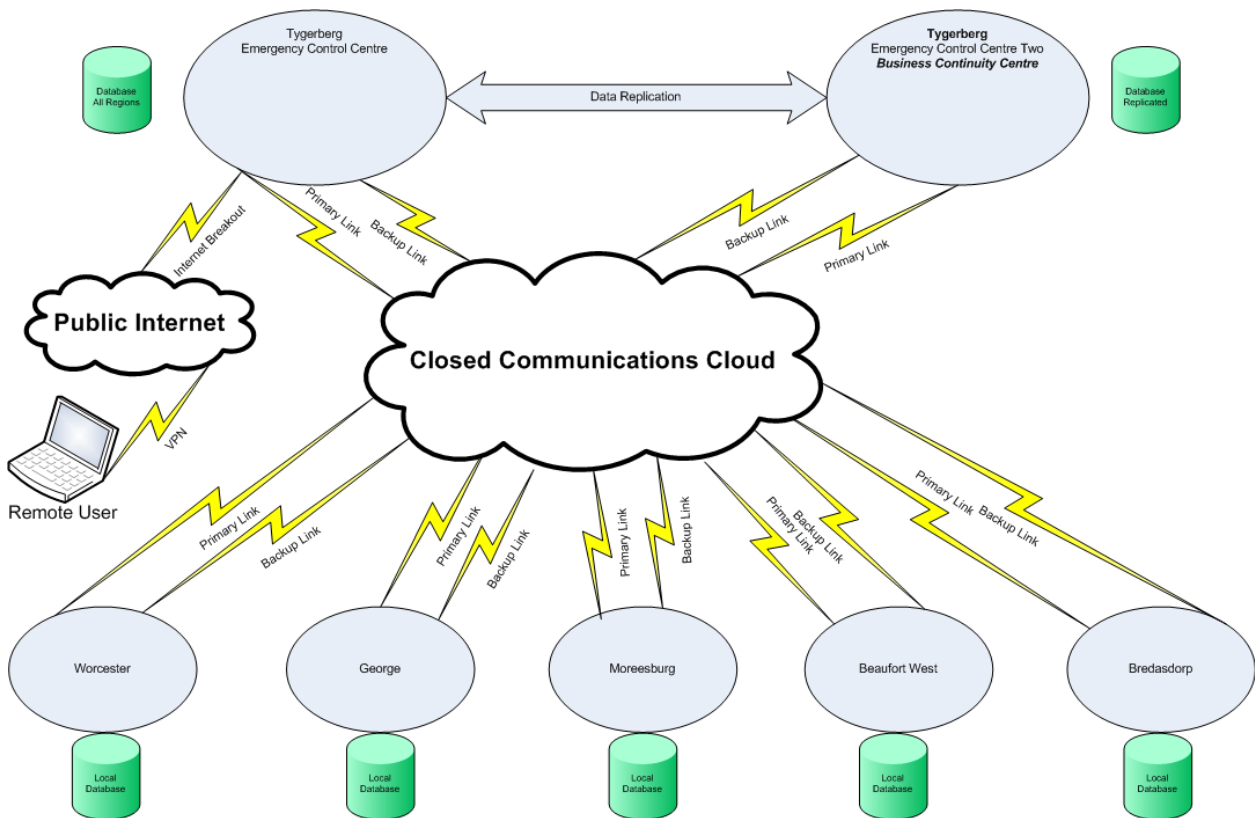

Figure 6: Data & Information availability - Hub and spoke data replication diagram

Access to up to date information in support of business processes must be maintained at all times with site independence as shown in the diagram above. Proposed technology must support resilience and availability requirements at all times.

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Architectural considerations to be addressed by the solution provider:

- Baseline technology architecture as it relates to Local and Wide Area Networks and Sites
- Technology measures included in the non functional requirements document [2]
- Target technology architecture – Envisaged target architecture guidance
- Views in support of failure points – Network, Communications, Processing.

The proposed solution must cater for all unplanned interruptions whether the disruption is caused by deliberate or negligent action or possible natural disasters.

The solution provider(s) must be able to prove that best practice guidelines and standards are followed to ensure completeness and auditability of the Disaster Recovery process.

2.4.3 Best Practice guidelines, standards and frameworks

Best practice guidelines and standards are to be followed when developing a solution or service which complies with the stated availability and continuity requirements [2].

- **COBIT [6]** – IT Governance Framework, Processes, Practices and controls associated with service continuity and availability.
- **ITIL Version 3 [5]** – Service Delivery and Service Support, processes associated with continuity and availability
- **ISO 27000 – 2005 Series [7]**, emphasis on *ISO 27002* Information security, service-oriented systems are exposed to a greater level of security threats, because of requirements for identity management, secure service composition, and trust in third-party services. Security mechanisms have to be architected into service-oriented systems and security policies have to be defined and enforced via SOA governance.

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DS4 Ensure Continuous Service *(cont.)*			
COBIT 4.1 Control Objective	Key Areas	ITIL V3 Supporting Information	ISO/IEC 27002:2005 Supporting Information
DS4.3 Critical IT resources	• Focus on critical infrastructure, resilience and prioritisation • Response for different time periods	• *SD 4.4.5.2 The proactive activities of availability management* • *SD 4.5.5.4 Stage 4—Ongoing operation*	• *14.1.1 Including information security in the business continuity management process* • *14.1.2 Business continuity and risk assessment*
DS4.4 Maintenance of the IT continuity plan	• Changing control to reflect changing business requirements	• **SD 4.5.5.4 Stage 4—Ongoing operation**	• **14.1.5 Testing, maintaining and reassessing business continuity plans**
DS4.5 Testing of the IT continuity plan	• Regular testing • Implementing action plan	• **SD 4.5.5.3 Stage 3— Implementation** • **SD 4.5.5.4 Stage 4—Ongoing operation**	• **14.1.5 Testing, maintaining and reassessing business continuity plans**
DS4.6 IT continuity plan training	• Regular training for all concerned parties	• **SD 4.5.5.3 Stage 3— Implementation** • **SD 4.5.5.4 Stage 4—Ongoing operation**	• **14.1.5 Testing, maintaining and reassessing business continuity plans**
DS4.7 Distribution of the IT continuity plan	• Proper and secure distribution to all authorised parties	• **SD 4.5.5.3 Stage 3— Implementation** • **SD 4.5.5.4 Stage 4—Ongoing operation**	• **14.1.5 Testing, maintaining and reassessing business continuity plans**
DS4.8 IT services recovery and resumption	• Planning for period when IT is recovering and resuming services • Business understanding and investment support	• **SD 4.4.5.2 The proactive activities of availability management** • **SD 4.5.5.4 Stage 4—Ongoing operation**	• *14.1.1 Including information security in the business continuity management process* • *14.1.3 Maintain or restore operations and ensure availability of information*
DS4.9 Offsite backup storage	• Offsite storage of all critical media, documentation and resources needed in collaboration with business process owners	• **SD 4.5.5.2 Stage 2— Requirements and strategy** • **SO 5.2.3 Backup and restore**	• *10.5.1 Information backup*
DS4.10 Post-resumption review	• Regular management assessment of plans	• *SD 4.5.5.3 Stage 3— Implementation* • *SD 4.5.5.4 Stage 4—Ongoing operation*	• *14.1.5 Testing, maintaining and reassessing business continuity plans*

Consideration should be given to the British Standards Institution (BSI) independent standard for business continuity.

BS 25999 – **1 2006 Part 1 Code of Practice & Part 2 the Standard [8]** – Structured approach for deriving a business continuity solution which includes the technology solution, and specifically the methodology for developing the business continuity plan.

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2.5   Application Architecture

2.5.1 Service-Oriented Architecture Requirements

The solution provider's offering must conform to the principles of a Service-Oriented Architecture (SOA). SOA concepts are described in detail under section 7, Annexure B: SOA Concepts**Error! Reference source not found.**.

2.5.1.1   Rationale for a Service-oriented Architecture

Many companies struggle with point-to-point integration solutions, EMS being a case in point today. EMS will adopt the best practice of service-orientation in order to overcome the integration issues.

Excerpt from Zapthink [10]:

"SOA can enable businesses to meet several key challenges when navigating a changing economy, by providing the following business benefits:

- **Business Agility** – With changing economic cycles placing a premium on an organisation's ability to adapt, the loosely-coupled nature of SOA enhances the ability to manage and adapt core processes. The visibility that SOA makes possible provides a clear window on business performance; the flexibility that SOA enables allows organisations to modify or compose new processes to respond to changes in the marketplace attributable either to economic growth or slowdown.

- **Controlling Integration Costs** – The cost of integration has traditionally proven a major hurdle for IT organisations in supporting the business. By leveraging open standards and abstracting the integration layer from the application tier, SOA reduces the need for developing integration code. It also reduces reliance on highly specialised skills covering specific platforms, languages, or middleware.

- **Business Process Visibility** – SOA can improve business process visibility by liberating processes from closed, often poorly documented application silos. Similarly, by enforcing governance practices throughout the Service lifecycle, SOA enables organisations to consistently enforce Service policies, while documenting enforcement for compliance with Service contracts and regulatory requirements.

- **Increased Reuse** – SOA reduces lead time and cost of deploying new functionality. It enables organisations to repurpose rather than replace existing software or business process assets, and compose rather than develop new processes or applications. As organisations increase software and process reuse, they can realise faster ROI through accelerated time-to-benefit.

- **Business Empowerment** – SOA plays an important role in supporting business-centric collaboration by empowering workgroups with the technology to overcome the business challenges that face them.

Effective collaboration is essential in empowering the enterprise and its people to more effectively differentiate the business and its offerings."

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2.5.1.2 Conceptual SOA Platform View

The following diagram portrays a high-level "business" view of the SOA integration platform. It is based on the model included in Annexure B: SOA Concepts [11].**Error! Reference source not found.Error! Reference source not found.** Please refer to this excerpt for more detail regarding this concept.
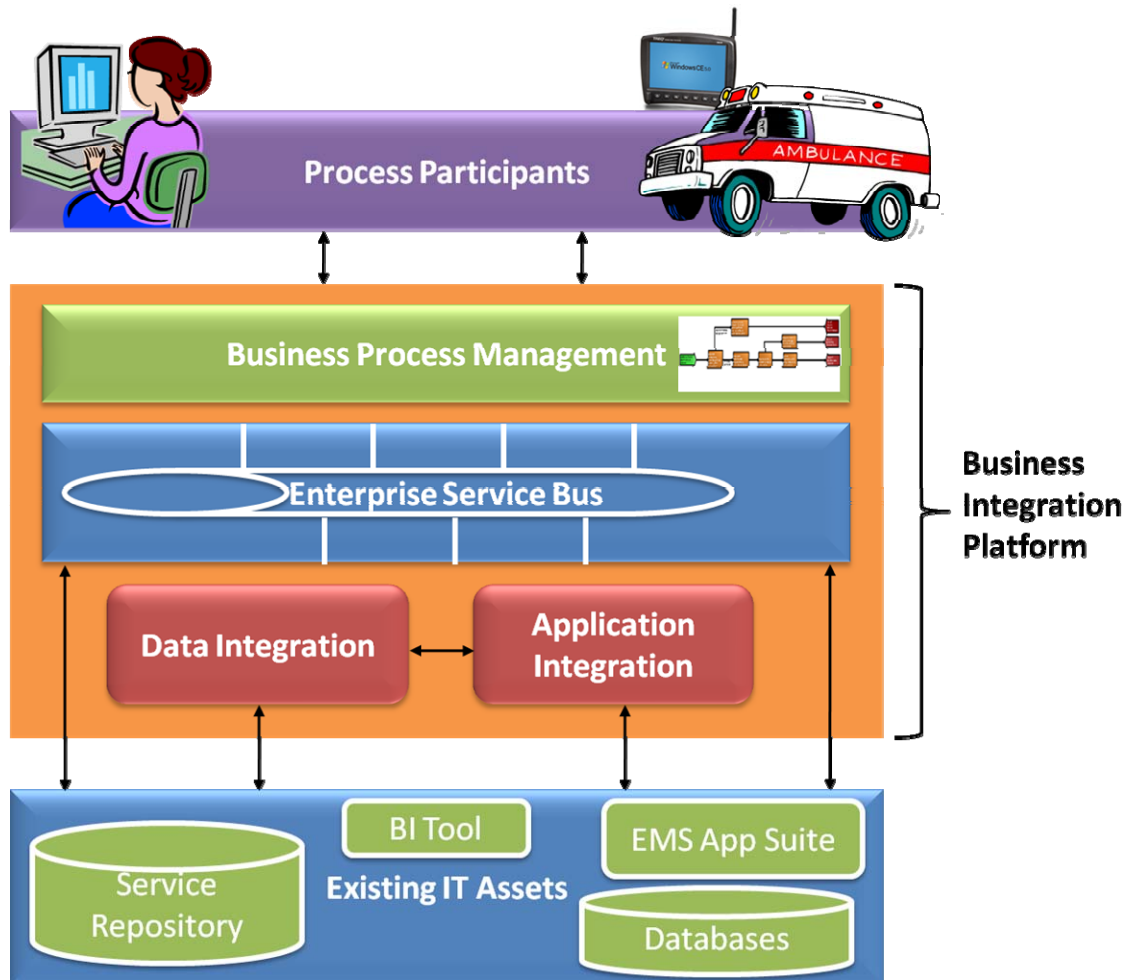
Figure 7: SOA-based Business Integration

Business Integration Platform Layers

The Business Integration Platform sits between the Process Participants and Existing IT Assets, where it co-ordinates their efforts:

- The Enterprise Service Bus (ESB) serves as the backbone for the entire platform. It provides the mechanism for continuously adapting the portfolio of available services to accommodate shifting needs

- The Business Process Management layer interfaces with the Process Participants, sequencing their tasks and providing automated assistance via the ESB. It provides process modelling, execution, and management components.

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- The Application and Data Integration layer interfaces with existing assets (i.e. applications, databases, hardware infrastructure, etc.) abstracting data and functions as necessary into atomic business services published through the ESB.

- Getting the right data to the right place at the right time is key to enabling a real-time flow of information

Service Repository and Registry

The ESB is under-pinned by a service repository and registry. It is extremely important that consistent policies be applied in the development and deployment of services:

- Business analysts need to understand what atomic business services are available for use in designing new processes

- IT architects must understand what service dependencies exist so that they can determine the impact of any changes

- Operations managers need a thorough knowledge of service usage and load characteristics so that they can ensure that service level agreements are met

The solution provider is expected to describe how their solution will meet these requirements.

2.5.1.3   Key Components of SOA [12]

Excerpt:

"Definition: SOA is a description of an IT infrastructure, supporting services, tools and processes intended to enable the independent construction of services which can be combined into meaningful business processes within the context of the enterprise (i.e. that extends beyond a single application).

SOA should describe the following aspects of services:

1. What a service is and how it is constructed, used, evolved and maintained;

2. How existing packaged and legacy systems are integrated into the service environment;

3. How services are combined;

4. How services communicate at a technical level (i.e., how they connect to each other and pass information);

5. How services interoperate at a semantic level (i.e., how they share common meanings for that information);

6. How services contribute to the enterprise business model, goals and strategy; and

7. What processes, frameworks and tools are needed to support SOA at the enterprise?"

The following diagram portrays the high-level aspects of service-oriented architecture from a more technical perspective. Further detail is **Error! Reference source not found.** [12].**Error! Reference source not found.Error! Reference source not found.**
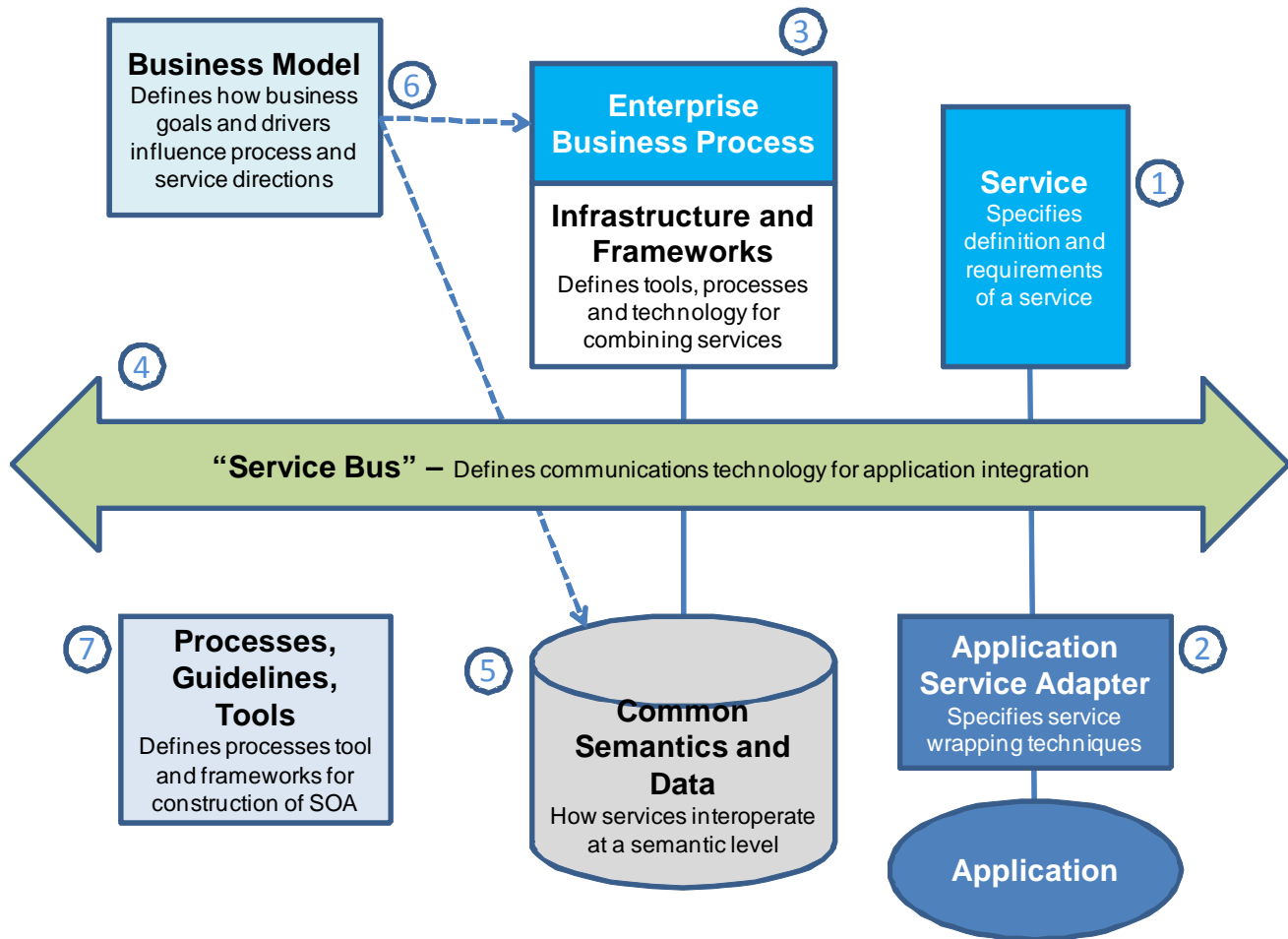
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Figure 8: High Level Aspects of SOA

2.5.2 Application Services

Reference is made here to "The TOGAF Technical Reference Model (TRM)" [9] which is an industry architecture framework standard. For further information regarding the TRM, refer to **Error! Reference source not found.Error! Reference source not found.**.

2.5.2.1   Application Software Requirements

The TOGAF TRM [9] recognises two categories of Application Software:

- **Business Applications**, which implement business processes for a particular enterprise or vertical industry. Such applications typically model elements of an enterprise's domain of activity or business processes. EMS is an example of a business application.
- **Infrastructure Applications**, which provide general-purpose business functionality, based on infrastructure services. By definition they are applications that are considered sufficiently ubiquitous, interoperable, and general-purpose within the enterprise to be effectively considered as part of the IT infrastructure. Examples of Infrastructure applications include:

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- o Electronic mail client services
- o Publish and subscribe
- o Calendaring and scheduling services
- o Workflow services
- o Presentation software
- o Document editing and presentation
- o Management applications, performing general-purpose system and network management functions for the system administrator
- o Software engineering tools, providing software development functions for systems development staff

The business application software functional requirements are addressed in the features document [1]. However, the following diagrams are replicated here for reference purposes and to provide context:

- **Error! Reference source not found.** provides a high-level view of the operational environment that the proposed solution (including infrastructure) is required to support.

- **Error! Reference source not found.** provides a high-level view of the business functions to be supported by the business application modules included in the solution
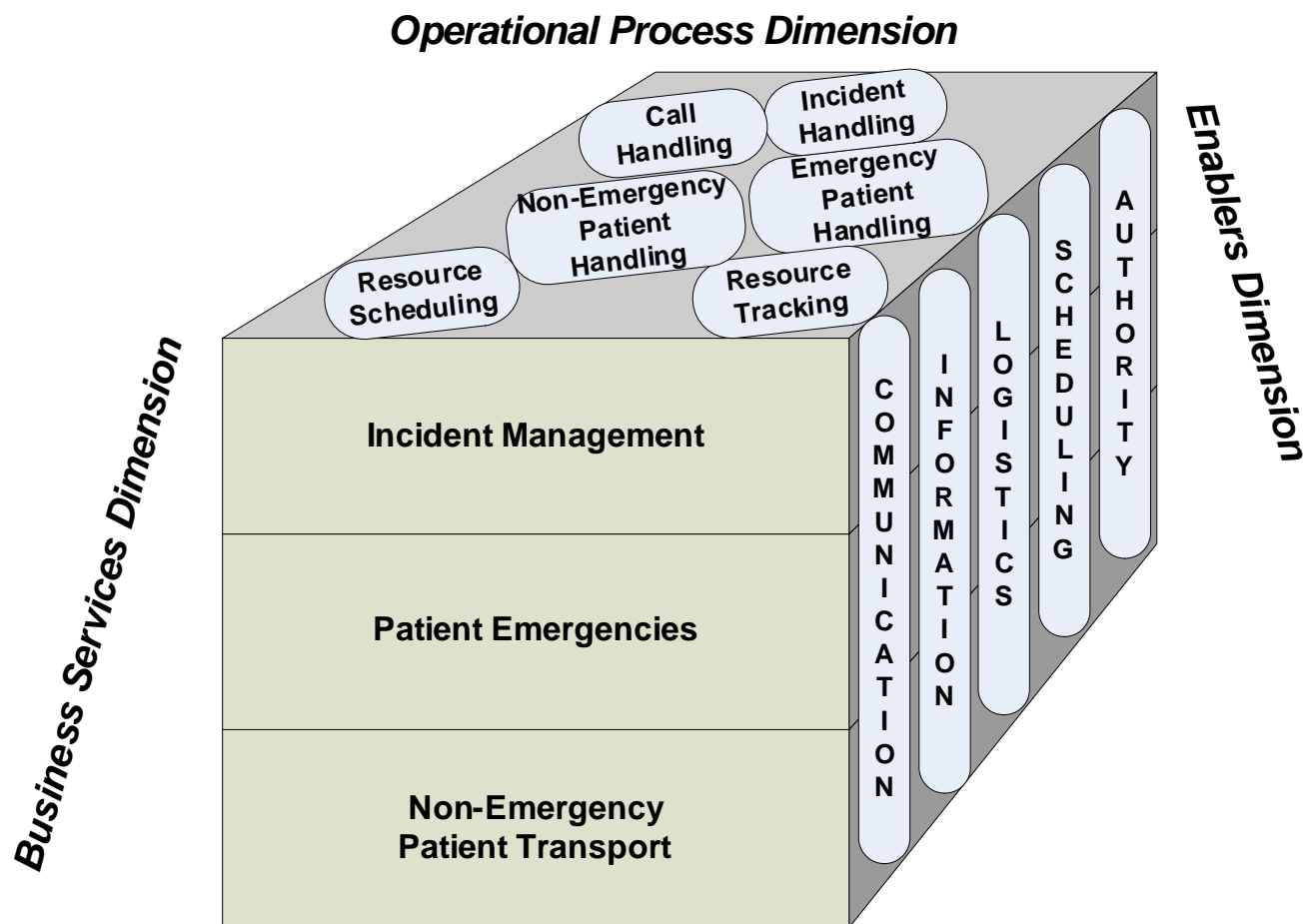

Figure 9: METRO EMS Operational Context

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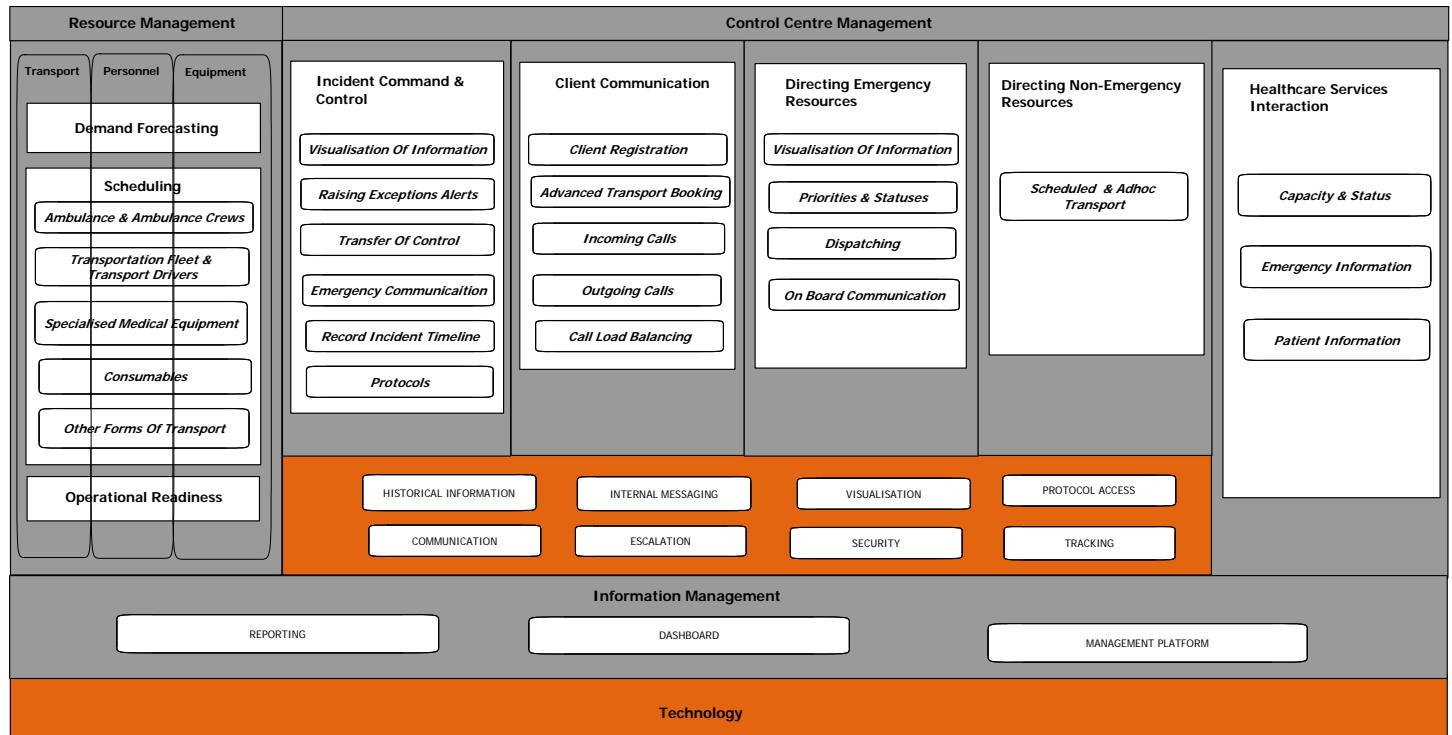
Figure 10: METRO EMS Business Functional Groups and Sub-Groups

Over and above the general architecture principles specified under section 2.2 above**Error! Reference source not found.**, the following additional application architecture principles apply. References are made to document B202 [2], section 2.2 IT Architecture Requirements where relevant:

- Layered application architecture (refer to B202)

- Modular and loosely coupled according to open industry standards (refer to B202 - Uniform Technologies)

- Platform independence – the ability to be hosted on multiple platform architectures (refer to B202 – Composability)

- **Escrow** considerations for source code and solution provider liability. If the supplier's business fails or alters business practices, escrow services allow the business to access critical assets and continue to conduct business as normal, without disruption.

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2.5.2.2 Service Requirements

The following services are based on TOGAF TRM's application platform services [9].

Service Category	Service Component	Description	Comments
3.**Graphics and Image Services** - provide functions required for creating, storing, retrieving, and manipulating images.	Imaging functions	Provide for scanning, creation, edit, compression and decompression of images in accordance with recognised standards Geographical maps/images	Industry standards: E.g. PIKS/IPI, OpenXIL, or XIE
4.**Data Management Services** - The management of data that can be defined independently of the processes that create or use it. It is maintained indefinitely and shared among many processes.	Data dictionary/repository services	Allow data administrators and information engineers to access and modify data about data (metadata) e.g. internal and external formats, integrity and security rules, and location within a distributed system. Allow end users and applications to define and obtain data that is available in the database.	
	Database Management System (DBMS) services	Provide controlled access to structured data. Provide concurrency control and facilities to combine data from different schemas. Different types of DBMS support different data models, including relational, hierarchical, network, object-oriented, and flat-file models. Accessible through a programming language interface, an interactive data manipulation language such as SQL, or an interactive/4GL interface. Most have specific services to create, populate, move, backup, restore, recover and archive databases.	Industry standard open databases – preferably one single DBMS SQL compliant
	Query processing functions	Provide for interactive selection, extraction, and formatting of stored information from files and databases. Invoked via user-oriented languages and tools (4GLs) which simplify the definition of searching criteria and aid in creating effective presentation of the retrieved information (including use of graphics).	Single reporting/ analytical tool – refer to Information Requirements [3]
	Report generation functions	Provide the capability to define and generate hardcopy reports composed of data extracted from a database	Single reporting/ analytical tool

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Service Category	Service Component	Description	Comments
	Networking/concurrent access functions	Manage concurrent user access to DBMS functions	
5.Data Interchange Services •Provide specialised support for the exchange of information between applications and the external environment. •Designed to handle data interchange between applications on the same platform and applications on different (heterogeneous) platforms.	Graphics data interchange services	Supported by device-independent descriptions of picture elements for vector-based graphics and descriptions of raster-based graphics.	
	Specialised data interchange services	Supported by specifications that describe data used by specific vertical markets.	E.g. For healthcare: •HL7 healthcare interoperability standards •DICOM medical image distribution and viewing standard
	Electronic Data Interchange (EDI) services	Used to create an electronic (paperless) environment for conducting commerce and achieving significant gains in quality, responsiveness, and savings afforded by such an environment.	Support for EDIFACT and XML conversions from/to HL7
	Fax, email, and sms services	Used to create, examine, transmit, and/or receive fax images, emails and sms's.	Fax to email gateway
	Raw graphics interface functions	Support graphics data file formats such as TIFF, JPEG, GIF, and CGM.	
	Text processing functions	Provide the capability to create, edit, merge, and format text.	
	Document processing functions	Provide the capability to create, edit, merge, and format documents. Enable the composition of documents that incorporate graphics, images, and even voice annotation, along with stylised text. Spell checks, columns, table of contents generation, etc.	
	Publishing functions	Incorporation of photo quality images and colour graphics Advanced formatting and style features e.g. wrapping text around graphic objects or pictures, etc.	
	Video processing functions	Capture, compose, edit, compress, and decompress video images using formats such as MPEG.	

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Service Category	Service Component	Description	Comments
	Audio processing functions	Capture, compose, edit, compress and decompress audio information.	
	Multimedia processing functions	Store, retrieve, modify, sort, search, and print all or any combination of the above media Includes microfilm media, optical storage technology for scanned or computer produced documents.	
	Media synchronisation functions	Synchronisation of streams of data such as audio and video for presentation purposes	
	Information presentation and distribution functions	Manage the distribution and presentation of information from batch and interactive applications Shield business area applications from information is used Formatting functions to accomplish distribution and presentation to a variety of business area applications and users Store, archive, prioritise, restrict and recreate information	
	Hypertext functions	Generation, distribution, location, search, and display of text and images locally and globally Searching, browsing, hypertext linking and presentation of multimedia information	
6.**User interface services** - define how users may interact with and application	Graphical Client/Server services	Define the relationships between client and server processes operating graphical user interface displays, usually within a network.	Thin client/web based
	Display Objects services	Define the characteristics of display elements such as colour, shape, size, movement, graphics context, user preferences, font management, and interactions among display elements.	
	Window Management services	Define how windows are created, moved, stored, retrieved, removed, and related to each other.	
	Dialogue Support services	Translate the data entered for display to that which is actually displayed on the screen	
	Printing services	Support output of text and/or graphical data, including any filtering or formal conversion necessary Ability to print all or part of a document, collate copies, size and orientation of output, etc.	

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Service Category	Service Component	Description	Comments
	Computer-Based Training and Online Help services	Provide integrated training environment on user workstations	
	Character-Based services	Support for non-graphical terminals.	We intend using MDTs which may be non-graphical
7.**International operation** - provides a set of services and interfaces that allow a user to define, select, and change between different culturally-related application environments supported by the particular implementation. In general, these services should be provided in such a way that internationalisation issues are transparent to the application logic.	Cultural convention services	Store and access rules and conventions for cultural entities maintained in a cultural convention repository called a "locale" that is available to all applications Typically include date and currency formats, collation sequences, and number formats	Locale formats and APIs
	Local language support services	Support more than one language concurrently on a system Menus, messages, forms etc. can be displayed in the language selected by the user	
8.**Location and directory services** - provide specialised support for locating required resources and for mediation between service consumers and service providers. The World Wide Web, based on the Internet, has created a need for locating information resources, which currently is mainly satisfied through the use of search engines. Advancements in the global	Directory services	Services for clients *(humans or computer programs)* to establish where resources *(e.g. names, email addresses, security certificates, printers, web pages, etc.)* are and how they can be reached	Compliance to internal ICT service providers
	Special-Purpose Naming services	Services that refer names (ordered strings of printable characters) to objects within a given context (namespaces). Objects typically hierarchically organised within namespaces e.g. file systems, security databases, process queues	
	Service location services	Provide access to "yellow pages" services in response to queries based on constraints	
	Registration services	Services to register identity, descriptions of services a resource is providing, and descriptions of the means to access them	
	Filtering services	Services to select useful information from data using defined criteria	

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Service Category	Service Component	Description	Comments
Internet, and in heterogeneous distributed systems, demand active mediation through broker services that include automatic and dynamic registration, directory access, directory communication, filtration, and accounting services for access to resources.	Accounting services	Services such as account open, account update, account balance, account detail, account close, account discounts, account bill/usage tally, account payment settlement based on message traffic and/or connection time, and/or resource utilisation, and/or broker-specific (e.g. value-based)	
9.**Transaction Processing (TP) services** - provide support for the online processing of information in discrete units called ''transactions'', with assurance of the state of the information at the end of the transaction. This typically involves predetermined sequences of data entry, validation, display, and update or inquiry against a file or database. It also includes services to prioritise and track transactions. TP services may include support for distribution of transactions to a combination of local and remote processors.	Transaction Manager services	Allow an application to demarcate transactions and direct their completion Include: •Starting a transaction •Co-ordination of recoverable resources involved in a transaction •Committing or rolling back transactions •Controlling timeouts on transactions •Chaining transactions together •Monitoring transaction status	
10.**Security services** - are necessary to protect sensitive information in the information system. The appropriate level of protection is determined based upon the value of the information to the business	Identification and Authentication services	Identification, accountability, and audit of users and their actions Authentication and account data Protection of authentication data Active user status information Password authentication mechanisms	Single sign-on VPN-C

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Service Category	Service Component	Description	Comments
	System Entry Control services	Warning to unauthorised users that the system is security-aware Authentication of users Information, displayed on entry, about previous successful and unsuccessful log-in attempts User initiated locking of a session preventing further access until the user has been re-authenticated	
	Audit services	Authorised control and protection of the audit trail, recording of detailed information security-relevant events, and audit trail control, management and inspection	
	Access Control services	Access control attributes for subjects (e.g. processes) and objects (e.g. files) Enforcement of rules for assignment and modification of access control attributes Enforcement of access controls Control of object creation and deletion, including ensuring that re-use of objects does not allow subjects to accidentally gain access to information previously held in the object	

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Service Category	Service Component	Description	Comments
	Non-Repudiation services	Provide proof that a user carried out an action, or sent or received information, at a particular time	
	Security Management services	Provide secure system set-up and initialisation, control of security policy parameters, management of user registration data, and system resources and restrictions on the use of administrative functions	
	Trusted Recovery services	Provide recovery facilities such as restoring from backups in ways that do not compromise security protection	
	Encryption services	Provide ways of encoding data such that it can only be read by someone who possesses an appropriate key or some other piece of secret information	
	Trusted Communication services	Provide: •Secure way for communicating parties to authenticate themselves to each other without the risk of an eavesdropper subsequently masquerading as one of the parties •Secure way of generating and verifying check values for data integrity •Data encipherment and decipherment for confidentiality and other purposes •Way to produce an irreversible hash of data for support of digital signature and non-repudiation functions •Generation, derivation, distribution, storage, retrieval, and deletion of cryptographic keys	
11.**Software Engineering Services** - The functional aspect of an application is embodied in the programming languages used to code it. Additionally, professional system developers require tools appropriate to the development and maintenance of applications.	Programming Language services	Provide the basic syntax and semantic definition for use by a software developer to describe the desired Application Software function Shell and executive script language services enable the use of operating system commands or utilities rather than a programming language	Ability to add on customisation external to core (vanilla) application Must not affect the ability to perform software updates/upgrades Non-proprietary languages

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Service Category	Service Component	Description	Comments
	Object Code Linking services	Provide the ability for programs to access the underlying application and operating system platform through APIs that have been defined independently of the computer language	
	Computer-Aided Software Engineering (CASE) Environment and	Systems and programs that assist in the automated development and maintenance of software	
	Graphical User Interface (GUI) Building services	Assist in the development of the Human Computer Interface (HCI) elements of applications	
	Scripting Language services	Provide interpreted languages which allow the user to carry out some complicated function in a simple way	
	Language Binding services	Provide mappings from interfaces provided by programming languages onto services provided by the Application Platform	
	Run-Time Environment service	Provide support for Application Software at run time, including locating and connecting dynamically linked libraries or even emulation of an operating environment other than the one that actually exists	
12.**System and Network Management Services** (under control of SITA) – to be dealt with at implementation time. Information systems are composed of a wide variety of diverse resources that must be managed effectively to achieve the goals of an open system environment. While the individual resources (such as printers, software, users, processors) may differ widely, the abstraction of these resources as managed objects allows for treatment in a uniform manner. The basic concepts of management	User Management services	Provide the ability to maintain a user's preferences and privileges	
	Configuration Management services	Address four basic functions: •Identification and specification of all component resources •Control, or the ability to freeze configuration items, changing them only through agreed processes •Status accounting of each configuration item •Verification through a series of reviews to ensure conformity between the actual configuration item and the information recorded about it Services include: Processor CM, Network CM, Distributed System CM, Topology CM, and Application CM	
	Performance Management services	Monitor performance aspects of hardware, platform and application software, and network components, and provide ways to tune the system to meet performance targets.	

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Service Category	Service Component	Description	Comments
	Availability and Fault Management services	Allow a system to react to the loss or incorrect operation of system components including hardware, platform software, and application software.	
	Accounting Management services	Provide the ability to cost services for charging and reimbursement.	
	Security Management services	Control the security services in accordance with applicable security policies.	
	Print Management services	Provide the ability to manage both local and remote print spooling services	
	Network Management services	Comprise elements of all the services described above, but are often treated as a separate service.	
	Backup and Restore services	Provide a multi-level storage facility to ensure continued data security in case of component or subsystem failure.	
	Online Disk Management services	Manage the utilisation of disk storage against threshold values and invoke corrective action.	
	Licence Management	Support the effective enforcement of software licence agreements.	
	Capacity Management services	Address 3 basic functions: •Capacity management analysing current and historic performance and capacity •Workload management to identify and understand applications that use the system •Capacity planning to plan required hardware resources for the future	
	Software Installation services	Support distribution, installation, removal, relocation, activation, and automatic update of software or data packages from transportable media or over networks.	
	Trouble Ticketing services	Support the generation, processing, and tracking of problem reports.	

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2.6 Reporting

The detailed reporting and management information requirements are specified in the information requirements document [3]. However in this section the focus is on management reporting and the concept of Business Intelligence from an architectural perspective.

Solution providers are required to describe (and demonstrate) how their solutions are architected with reference to the Gartner's definition [14] below in terms of best practice.

Market Definition/Description

"BI platforms are used to build applications that help organisations learn and understand their business. Gartner defines a BI platform as a software platform that delivers the 12 capabilities listed below. These capabilities are organised into three categories of functionality: integration, information delivery and analysis. Information delivery is the core focus of most BI projects today, but we see an increasing need to focus more on analysis to discover new insights, and on integration to implement those insights.

Integration:

- **BI infrastructure** — All tools in the platform should use the same security, metadata, administration, portal integration, object model and query engine, and should share the same look and feel.

- **Metadata management** — This is arguably the most important of the 12 capabilities. Not only should all tools leverage the same metadata, but the offering should provide a robust way to search, capture, store, reuse and publish metadata objects such as dimensions, hierarchies, measures, performance metrics and report layout objects.

- **Development** — The BI platform should provide a set of programmatic development tools — coupled with a software developer's kit for creating BI applications — that can be integrated into a business process, and/or embedded in another application. The BI platform should also enable developers to build BI applications without coding by using wizard-like components for a graphical assembly process. The development environment should also support Web services in performing common tasks such as scheduling, delivering, administering and managing.

- **Workflow and collaboration** — This capability enables BI users to share and discuss information via public folders and discussion threads. In addition, the BI application can assign and track events or tasks allotted to specific users, based on predefined business rules. Often, this capability is delivered by integrating with a separate portal or workflow tool.

Information Delivery

- **Reporting** — Reporting provides the ability to create formatted and interactive reports with highly scalable distribution and scheduling capabilities. In addition, BI platform vendors should handle a wide array of reporting styles (for example, financial, operational and performance dashboards).

- **Dashboards** — This subset of reporting includes the ability to publish graphically intuitive displays of information, including dials, gauges and traffic lights. These displays indicate the state of the performance metric, compared with a goal or target value. Increasingly, dashboards are used to disseminate real-time data from operational applications.

- **Ad hoc query** — This capability, also known as self-service reporting, enables users to ask their own questions of the data, without relying on IT to create a report. In particular, the tools must have a robust semantic layer to allow users to navigate available data sources. In addition, these tools should offer query governance and auditing capabilities to ensure that queries perform well.

- **Microsoft Office integration** — In some cases, BI platforms are used as a middle tier to manage, secure and execute BI tasks, but Microsoft Office (particularly Excel) acts as the BI client. In these cases, it is vital

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that the BI vendor provides integration with Microsoft Office, including support for document formats, formulas, data "refresh" and pivot tables. Advanced integration includes cell locking and write-back.

Analysis

- **OLAP** — This enables end users to analyse data with extremely fast query and calculation performance, enabling a style of analysis known as "slicing and dicing." This capability could span a variety of storage architectures such as relational, multidimensional and in-memory.

- **Advanced visualisation** — This provides the ability to display numerous aspects of the data more efficiently by using interactive pictures and charts, instead of rows and columns. Over time, advanced visualisation will go beyond just slicing and dicing data to include more process-driven BI projects, allowing all stakeholders to better understand the workflow through a visual representation.

- **Predictive modelling and data mining** — This capability enables organisations to classify categorical variables and estimate continuous variables using advanced mathematical techniques.

- **Scorecards** — These take the metrics displayed in a dashboard a step further by applying them to a strategy map that aligns key performance indicators to a strategic objective. Scorecard metrics should be linked to related reports and information in order to do further analysis. A scorecard implies the use of a performance management methodology such as Six Sigma or a balanced scorecard framework.

Whatever tool EMS select as part of the solution may be extended for use within the Department of Health.

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Annexure A: Technical Reference Model [9]

The TOGAF1 Foundation Architecture is an architecture that provides a foundation on which specific architectures and architectural components can be built. This Foundation Architecture is embodied in the Technical Reference Model (TRM). The TRM is universally applicable and therefore can be used to build any system architecture.

The diagram below depicts the TOGAF[1] Technical Reference Model which is underpinned by a taxonomy of generic platform services. The taxonomy defines the terminology and provides a coherent description of its components, and the model is a graphical representation of the taxonomy to act as an aid for understanding.
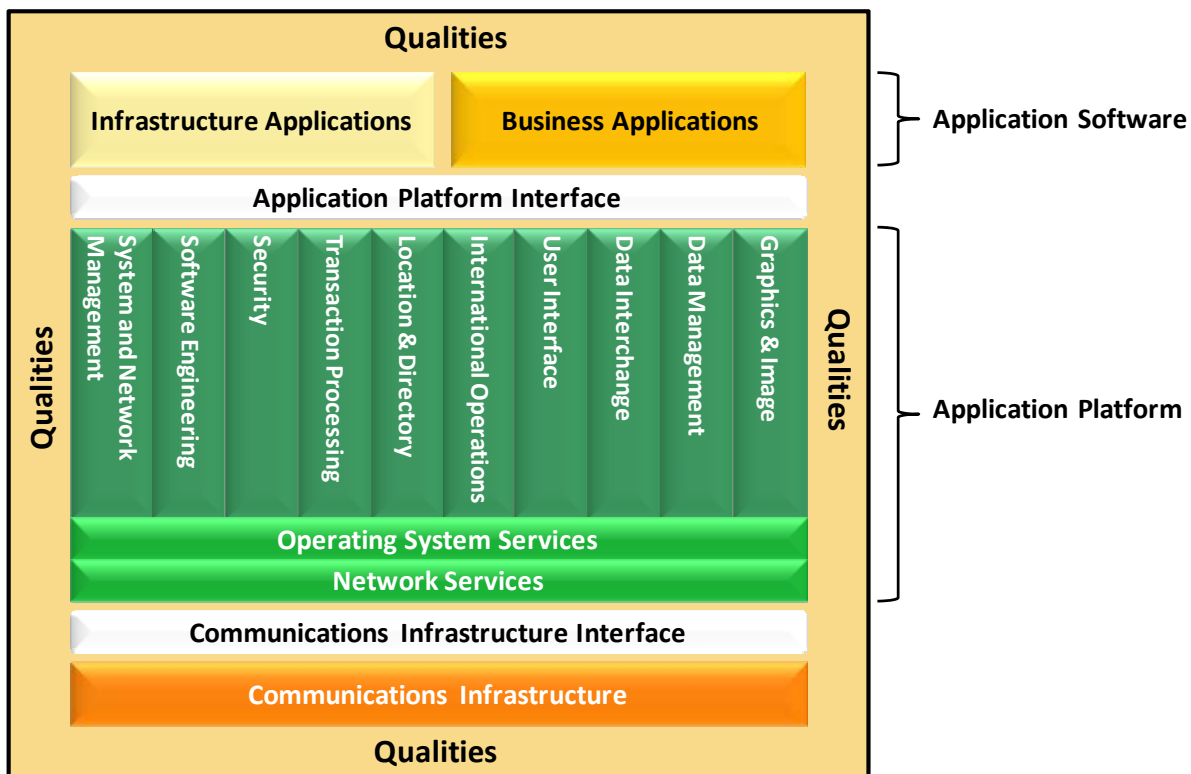

Figure 11: TOGAF Technical Reference Model (TRM)

IT architectures derived from TOGAF may differ greatly depending on the requirements of the information system. In practice, architectures will not include all of the services discussed here, and many will include additional services to support Application Software that is specific to the organisation or to its vertical industry.

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[1]   TOGAF™ Version 9

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1. TRM: Application Software

The detailed TRM recognises two categories of Application Software:

- Business Applications, which implement business processes for a particular enterprise or vertical industry. The internal structure of business applications relates closely to the specific application software configuration selected by an organisation.

- Infrastructure Applications, which provide general-purpose business functionality, based on infrastructure services.

2. TRM: Application Platform

The TOGAF TRM focuses on the Application Platform that is comprised of a set of service categories. The ''higher-level function'' i.e. the set of Application Software, runs on top of the Application Platform in order to address the enterprise's business requirements.

It is important to recognise that the Application Platform in the TOGAF TRM is a single, generic, conceptual entity. From the viewpoint of the TOGAF TRM, the Application Platform contains all possible services. In a specific Target Architecture, the Application Platform will contain only those services needed to support the required functions.

It is also important to recognise that many of the real-world IT systems that are procured and used today to implement a Technology Architecture come fully equipped with many advanced services, which are often taken for granted by the purchaser. For example, a typical desktop computer system today comes with software that implements services from most if not all of the service categories of the TOGAF TRM. These "service bundles" are represented in the Technology Architecture in the form of ''building blocks''.

In addition to supporting Application Software through the Application Platform Interface (API), services in the Application Platform may support each other, either by openly specified interfaces which may or may not be the same as the API, or by private, unexposed interfaces. A key goal of architecture development is for service modules to be capable of replacement by other modules providing the same service functionality via the same service API. *Use of private, unexposed interfaces among service modules may compromise this ability to substitute and should be avoided to facilitate future transition.*

3. TRM: Communications Infrastructure

The Communications Infrastructure provides the basic services to interconnect systems and provide the basic mechanisms for opaque transfer of data. It contains the hardware and software elements which make up the networking and physical communications links used by a system, and of course all the other systems connected to the network. It deals with the complex world of networks and the physical Communications Infrastructure, including switches, service providers, and the physical transmission media.

4. TRM: Application Platform Interface

The Application Platform Interface (API) specifies a complete interface between the Application Software and the underlying Application Platform across which all services are provided. A rigorous definition of the interface results in application portability, provided that both platform and application conform to it. For this to work, the API definition must include the syntax and semantics of not just the programmatic interface, but also all necessary protocol and data structure definitions.

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Portability depends on the symmetry of conformance of both applications and the platform to the architected API. That is, the platform must support the API as specified, and the application must use no more than the specified API.

The API specifies a complete interface between an application and one or more services offered by the underlying Application Platform. An application may use several APIs, and may even use different APIs for different implementations of the same service.

5. TRM: Communications Infrastructure Interface

The Communications Infrastructure Interface is the interface between the Application Platform and the Communications Infrastructure.

6. TRM: Qualities

Besides the set of components making up the TRM, there is a set of attributes or qualities that are applicable across the components. For example, for the management service to be effective, manageability must be a pervasive quality of all platform services, applications, and Communications Infrastructure services.

Another example of a service quality is security. The proper system-wide implementation of security requires not only a set of Security services, corresponding to the security services category shown in the platform, but also the support (i.e., the ''security awareness'') of software in other parts of the TRM. Thus, an application might use a security service to mark a file as read-only, but it is the correct implementation of the security quality in the operating system services which prevents write operations on the file. Security and operating system services must co-operate in making the file secure.

Qualities are specified in detail during the development of a Target Architecture. Some qualities are easier than others to describe in terms of standards. For instance, support of a set of locales can be defined to be part of the specification for the international operation quality. Other qualities can better be specified in terms of measures rather than standards. An example would be performance, for which standard APIs or protocols are of limited use.

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Annexure B: SOA Concepts

1. Business Integration through Service-Oriented Architecture [11]

The following excerpt puts across the high-level SOA concepts clearly.

In today's rapidly changing business environment, organisations of all types face one common and persistent challenge: how to become—and remain—agile enough to satisfy ever-increasing customer expectations and accommodate new compliance mandates, all while staying ahead of the competition.

The solution is business integration. Combining business process management (BPM) and a service-oriented approach to IT management, business integration promotes efficiency and automation across all processes, ensuring that existing IT assets support actual business processes and new IT investment is focused on maximum return. Although simple in concept, business integration has historically proven difficult to implement; however, with today's service-oriented architecture (SOA)–based approach—which puts business and IT on equal footing—this doesn't have to be the case.

By giving the business side of an organisation the tools to map their processes conceptually and by providing IT departments with the tools to map existing services, data, and applications to those requirements, BPM and SOA make business integration possible. Together, they offer a unifying work concept for both business and IT: *atomic business service.* In this model, the business decomposes processes into distinguishable, but minute, business services while IT builds up existing assets and new components into the same—leading the two sides of the organisation to meet in the middle. In addition, business and IT are linked by a flexible backbone, called an enterprise service bus (ESB) that aids adaptation. The result is a flexible infrastructure that allows companies to quickly add new services, swap in external services for internal services, transition from older to newer services, rearrange the sequence of services, enforce governance policies, and monitor service execution.

SOA-based business integration solves integration problems by introducing two important innovations: a conceptual work unit linking business and IT and a backbone that flexibly mediates among work units. The unifying work unit in this case is the atomic business service—a concept that makes sense to both the business and IT sides of an organisation. For those on the business side, this atomic business service represents a collection of similar tasks that correspond to those that a small department (such as payment processing) might provide in the brick-and-mortar world. To IT, this atomic business service represents a collection of related functions that correspond to what an application module (such as a payment processor) might have provided in the old client/server world.

From the business perspective, an atomic business service is the lowest-level service that makes sense—without imposing any particular IT-level architecture or design. And from the IT perspective, an atomic business service represents the highest-level service that makes sense—without imposing any particular business-level process flow. Obviously, these definitions are flexible enough to allow for varying interpretations, depending on the company and industry.

Error! Reference source not found. Figure 12 illustrates how this conceptual work unit bridges the gap between business and IT. The business disaggregates its business process models downward toward the atomic business services layer, while IT aggregates software assets upward toward that layer using service-oriented integration. They then meet in the middle and negotiate a consensus view of the necessary atomic business services.
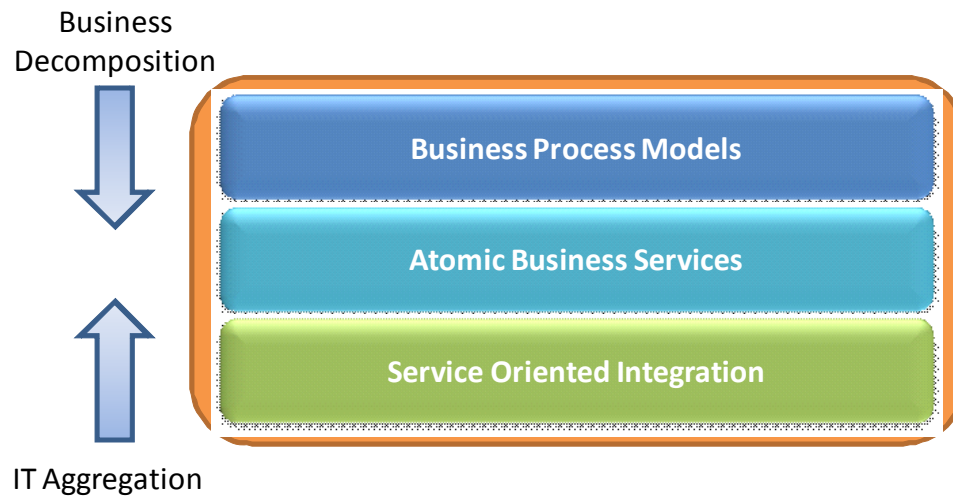
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Business Decomposition

Business Process Models

Atomic Business Services

Service Oriented Integration

IT Aggregation

Figure 12: Converging on Atomic Business Services

The second innovation behind SOA-based business integration is the ESB, which provides the mechanism for continuously adapting the portfolio of available services to accommodate shifting needs. No service portfolio is perfect for every situation; however, rather than requiring constant updates to constituent services, the ESB can adaptively mediate among them; for example, if two services use slightly different formats for their messages, the ESB can translate between them. Alternatively, if a business change in one area requires a new version of a service, the ESB can route requests that require enhanced functionality to the new version while routing requests that assume only basic functionality to the old version. Thus, in addition to providing common ground for business and IT, an SOA also gives deployed solutions the flexibility to bend without breaking.

2. The Service-Oriented Architecture platform

Although the ESB isn't the only component of SOA-based business integration, it does serve as the backbone for an entire platform. **Error! Reference source not found.** Figure 13 reveals the complete picture, but in brief this is how the SOA platform looks and works:

- The business integration platform sits between the process participants and existing IT assets, where it coordinates their efforts.

- The business process management layer interfaces with the process participants, sequencing their tasks and providing automated assistance via the ESB.

- The application and data integration layer interfaces with existing assets, abstracting data and functions as necessary into atomic business services published through the ESB.
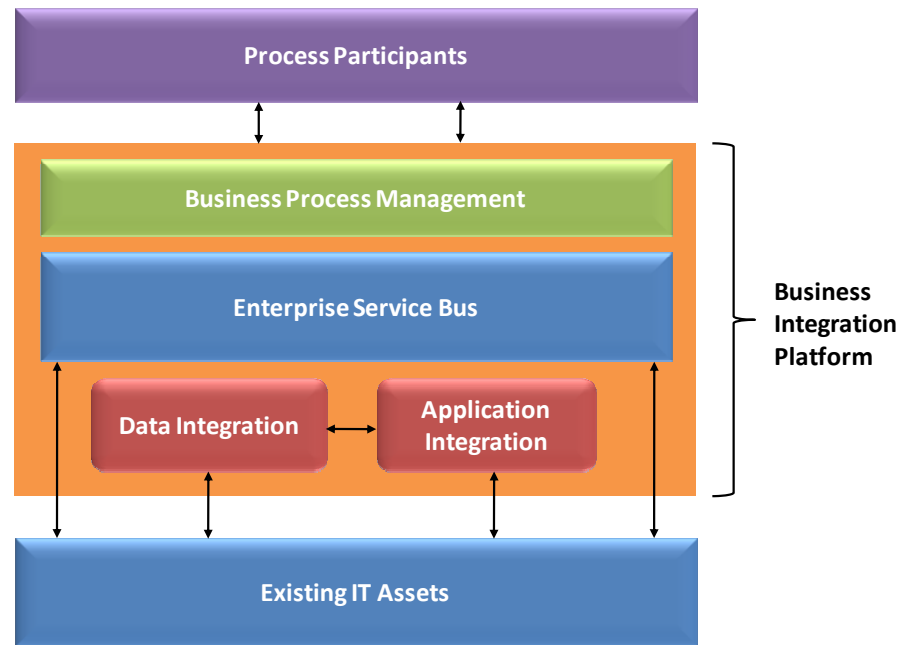
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Figure 13: SOA-based Business Integration

3. Business Process Management

From the business perspective, the most visible portion of the business integration platform is the business process management layer, which provides process modelling, execution, and management components.

Modelling components allow business analysts to write the story of each business process using conventions such as Business Process Modelling Notation. They also allow analysts to document process steps and mock up user interface screens to illustrate how people will contribute to the process. Finally, these modelling components can simulate automated and manual task flows to help analysts refine the story down to an optimised collection of atomic business services.

Execution components translate a process into executable instructions and then invoke the necessary atomic business services, usually through the ESB. They also provide a Web-based workspace for users to execute their tasks and manually handle exceptions. Monitoring components track real-time process flow and long-term process metrics to minimise response times to both sudden crises and evolving environments. Some Business Process Management Suites deliver all of these modelling, execution and management components in a single package with proven reliability, availability, and scalability for change in ownership.

4. Data Integration

Businesses are powered by information. When accurate, integrated information is delivered in real time, organisations can make sound decisions. Getting the right data in the right place at the right time is the key to enabling such a real-time flow of information:

- **The right data.** The data must not only be appropriate for the use that is intended, but it must also be accurate and reliable.

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- **The right place.** The overall information ecosystem consists of multiple operational and analytical systems. Each system needs to leverage and benefit from the data within the other systems, regardless of location.

- **The right time.** Data can quickly become stale. A decision support system that does not get the data in time is useless. A shipping application that does not get order information before cut-off time is not efficient. Getting data at the right time—with a latency that is appropriate for the intended use of this data—is one of the most important challenges faced by businesses today.

5. Enterprise Service Bus

Serving as much more than just a transport, an ESB also acts as an intelligent router, translator, policy enforcer, aggregator, and monitor. In addition to managing message flows between services, applying management and security policies, and supporting SOA governance across the enterprise, an ESB also facilitates cooperation among lower-level data and application services—all of which makes employing best practices essential when using an ESB.

6. Service Repository and Registry

As the SOA-based business integration infrastructure grows within an enterprise, it becomes increasingly important that consistent policies be applied to the development and deployment of services, and that all key parties have a complete understanding of those services—that is, which ones are available for use, what they do, and which clients and business processes will consume them.

- Business analysts need to understand what atomic business services are available for use in designing new processes.

- IT architects must understand what service dependencies exist so that they can determine the impact of any changes.

- Operations managers need a thorough knowledge of service usage and load characteristics so that they can ensure that service-level agreement commitments are met.

7. Key Components of SOA [12]

The following excerpt provides a more technical view of the components of SOA.

"Definition: SOA is a description of an IT infrastructure, supporting services, tools and processes intended to enable the independent construction of services which can be combined into meaningful business processes within the context of the enterprise (i.e. that extends beyond a single application).

SOA should describe the following aspects of services:

1. What a service is and how it is constructed, used, evolved and maintained;

2. How existing packaged and legacy systems are integrated into the service environment;

3. How services are combined;

4. How services communicate at a technical level (i.e., how they connect to each other and pass information);

5. How services interoperate at a semantic level (i.e., how they share common meanings for that information);

6. How services contribute to the enterprise business model, goals and strategy; and

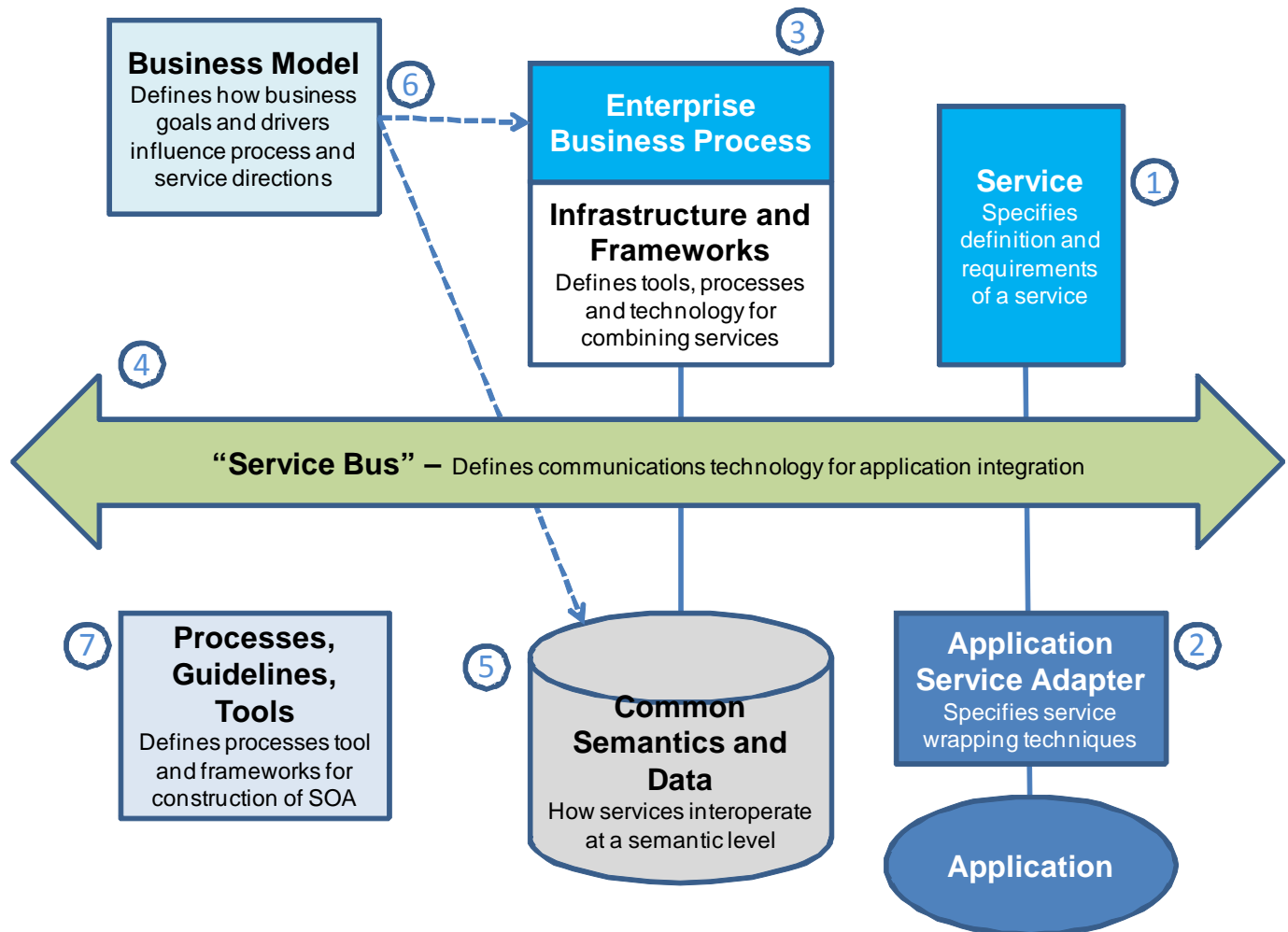7. What processes, frameworks and tools are needed to support SOA at the enterprise?"

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Figure 14: High Level Aspects of SOA

Error! Reference source not found. Figure 14 illustrates the various aspects of service-oriented architecture. The numbered circles in the figure correspond to the numbered list.

1. **What is a service and how is it constructed** – The architecture must define the structure of a service and how to build and use one. For each type of service, the architecture should specify the:

   - Granularity – The appropriate size of the service;

   - Type / style of interface – Guidelines for interface design. For example, business services should be accessed via interfaces that pass documents.

   - Configuration mechanisms – Standard mechanisms for configuring services.

   - Other artefacts – The set of artefacts that are required to support a service both at runtime and design time, such as design models and specifications, documentation, test plans, etc.

   - Dependency management and other patterns – Specific design patterns that should be followed to keep services independent and reusable.

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2. **How to find, evolve and maintain services** – The architecture must describe the complete lifecycle of services, including versioning and backward compatibility requirements.

3. **How to integrate existing applications** into the service environment – The reality is that much of the business functionality in enterprises today is not in the form of a service. An essential part of an SOA is how this existing functionality can be exposed as services and connected to the service environment. The SOA must specify the general mechanism for defining these services, wrapping them and connecting them, with specific implementations for the most common type of system.

4. **How to combine services** - The SOA must describe the methods, tools and infrastructure for combining services into larger business services and business processes.

5. **How services communicate** - A service's value lies in its ability to be combined with other services to create an agile enterprise. To do this, it must be designed to fit into a specific technical, semantic and operational environment. This environment (infrastructure) and the services it provides must be described by the architecture. The service bus is a key component of the application infrastructure. It provides the communications infrastructure (e.g. an ESB) to enable services to integrate. The SOA must specify the service bus along with the guidelines for using that infrastructure.

6. **Common enterprise semantics and data definitions** – The SOA must define the common semantic environment in which the services operate. For example: What data schema must be common across services for consistency and interoperability?

7. **Business model** - A business model is a key to understanding the requirements for a common enterprise, especially for shared data. The SOA does not necessarily define the business model, but must define how the business model is used to design services and enterprise business processes, and how it drives SOA requirements.

8. **The development environment / frameworks / infrastructure / tools required to support the SOA program** - It is not enough to describe what services are; the architecture must enable the easy and efficient creation of those services. Framework and tools are key to allowing independent organisations to create consistent services.

At the enterprise level, a major goal of SOA is to build up a library of services that can be combined together into business processes to support and improve enterprise business goals. In order to achieve this, it is not sufficient to simply build random services, even if they are individually well designed. The 'Architecture' part of SOA must deal with both the construction of services and the combination of them, providing enough contexts so that services can be constructed by independent organisations.

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Annexure C: Glossary of Terms

Term	Description
Application Binary Interface (ABI)	Describes the low-level interface between an application program and the operating system or another application.
Cipher/Cypher	A cryptographic system in which units of plain text of regular length, usually letters, are arbitrarily transposed or substituted according to a predetermined code Encipher/Encypher – to encode according to such a cryptographic system Decipher/Decypher – to reverse the above
DICOM	The Digital Imaging and Communications in Medicine (**DICOM**) standard for distributing and viewing any kind of medical image regardless of the origin.
escrow	**Escrow** is a legal term which means, "money, goods or a written document, held by a trusted third party, pending the fulfilment of some condition". Businesses often **depend on assets** they do not own themselves or legally control such as back-end software packages, accounting and productivity applications, or E-commerce solutions. If the supplier's business fails or alters business practices, **escrow services** allow your business to access critical assets and continue to conduct business as normal, without disruption
HL7	HL7 produces the world's most widely used standards for healthcare interoperability. Most of the leading suppliers use and support the development of HL7 standards across six continents. HL7 is an accredited standards development organisation, regulated by ANSI (American National Standards Institute). Over the years it has absorbed and built on other standards such as the ASTM E.1238 (the first standard for exchanging laboratory test results), and IEEE P1157 (MEDIX). It also collaborates with other healthcare standards groups such as ACR/NEMA DICOM (used for medical imaging), the European CEN/TC 251 and the International ISO 215 technical committees, with substantial cross-membership of these groups, as well as with general IT standards bodies including W3C, OMG and OASIS.
Network Topology	The physical interconnections of the elements (links, nodes, etc.) of a computer network. A local area network (LAN) is one example of a network that exhibits both a physical topology and a logical topology. Any given node in the LAN has one or more links to one or more other nodes in the network and the mapping of these links and nodes in a graph results in a geometrical shape that may be used to describe the physical topology of the network. Likewise, the mapping of the data flows between the nodes in the network determines the logical topology of the network. The physical and logical topologies may or may not be identical in any particular network. *From Wikipedia, the free encyclopaedia [15]*
Raster Graphics	In computer graphics, a **raster graphics** image or **bitmap** is a data structure representing a generally rectangular grid of pixels, or points of colour, viewable via a monitor, paper, or other display medium. Raster images are stored in image files with varying formats *From Wikipedia, the free encyclopaedia [15]*

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Vector Graphics	**Vector graphics** is the use of geometrical primitives such as points, lines, curves, and shapes or polygon(s), which are all based on mathematical equations, to represent images in computer graphics.
	From Wikipedia, the free encyclopaedia [15]

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