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**Department of Higher Education and Training
Post-School Education and Training**

**Central Application Service
Enterprise Architecture**

Chapter 5 – ICT Architecture and Infrastructure

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1 Terms of Reference

This ICT Architecture and Infrastructure report has been prepared by Learning Strategies as part of the assistance to the Department of Higher Education and Training for the development of an Enterprise Architecture as phase one for a National Post-School Education and Training (PSET) Central Applications Services (CAS).

This chapter completes step 4.3 of the Project Plan, presents deliverable number 4.5 in Terms of Reference and forms chapter 5 of the consolidated CAS Enterprise Architecture.

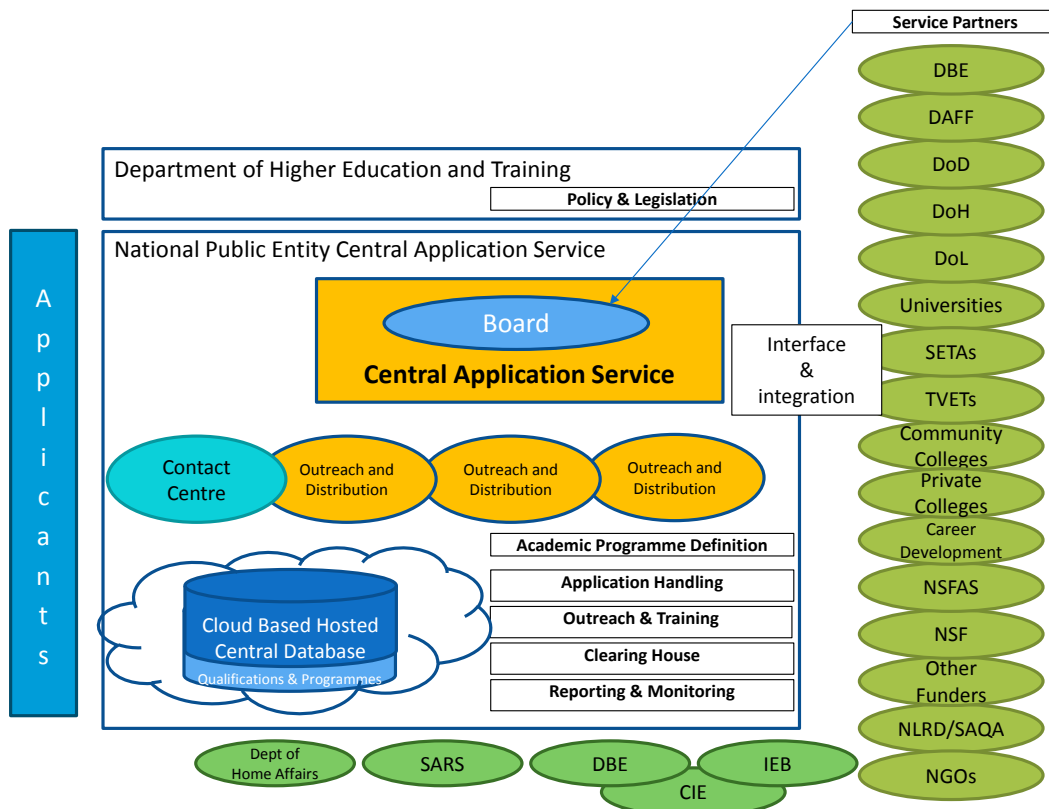
The purpose of this document is to present an assessment of the IT Landscape within the PSET sector as this affects the PSET CAS, define an appropriate Application and Integration Architecture for the PSET CAS systems solutions, and define an appropriate Infrastructure for the PSET CAS.

2 PSET IT Landscape Assessment

2.1 Context

The establishment of the CAS for the PSET sector will be a complex and extended project which will touch on a broad range of stakeholders and interested and affected parties. Crucial to the success of the implementation will be the extent to which underlying systems platform for the PSET CAS can effectively and efficiently meet the requirements of the stakeholders, but also integrate with the key service providers that play a part in the operation of the PSET CAS.

The diagram below illustrates the generic Service Model as adopted for the PSET CAS.



The diagram highlights the large number of service partners with whom the PSET CAS will interact, including:

- Higher Education institutions;
- Government Departments;
- Government Agencies;
- Public Entities; and
- Non-governmental organisations.

2.2 PSET IT Landscape Assessment

These service partners have differing IT landscape and an assessment of the IT Landscape within the PSET sector was conducted, as this affects the PSET CAS. The results of the assessment are included in the table below. It is important to note however that the Architecture Impacts listed below would need to be reviewed and possibly emended and refined during the Detailed Design phase.

Service Partner	Expected IT Integration	Service Partner Landscape	Architecture Impacts
Universities	Deep integration relating to application flow, and exposure of CAS data to Universities	Mostly running ITS or PeopleSoft (allowing for a common integration approach). Unisa implementing SITS (by UK firm Tribal)	<ol style="list-style-type: none"> 1. Web Service architecture for application flow 2. Institution Front End to allow access to CAS data
TVET College	Deep integration relating to application flow, and exposure of CAS data to TVETs (including referrals and CACH)	Range of back end systems, less advanced than Universities. In flux due to incorporation into DHET	<ol style="list-style-type: none"> 1. Web Service architecture for application flow 2. Institution Front End to allow access to CAS data
Community Colleges	Use CAS application for "registration" Exposure of CAS data to Community Colleges (including referrals and CACH)	Some may not have back end systems at all, far less advanced than Universities. In flux due to incorporation into DHET	<ol style="list-style-type: none"> 1. Institution Front End to allow access to CAS
SETAs	Deep integration relating to application flow, and exposure of CAS data to SETAs	Typically custom-built systems around a few leading providers (may allow for a common integration approach) but with a number of different system platforms	<ol style="list-style-type: none"> 1. Web Service architecture for application flow 2. Institution Front End to allow access to CAS data
Private Colleges	Deep integration relating to application flow, and exposure of CAS data to Private Colleges (including referrals and CACH)	Unknown	<ol style="list-style-type: none"> 1. Web Service architecture for application flow 2. Institution Front End to allow access to CAS data



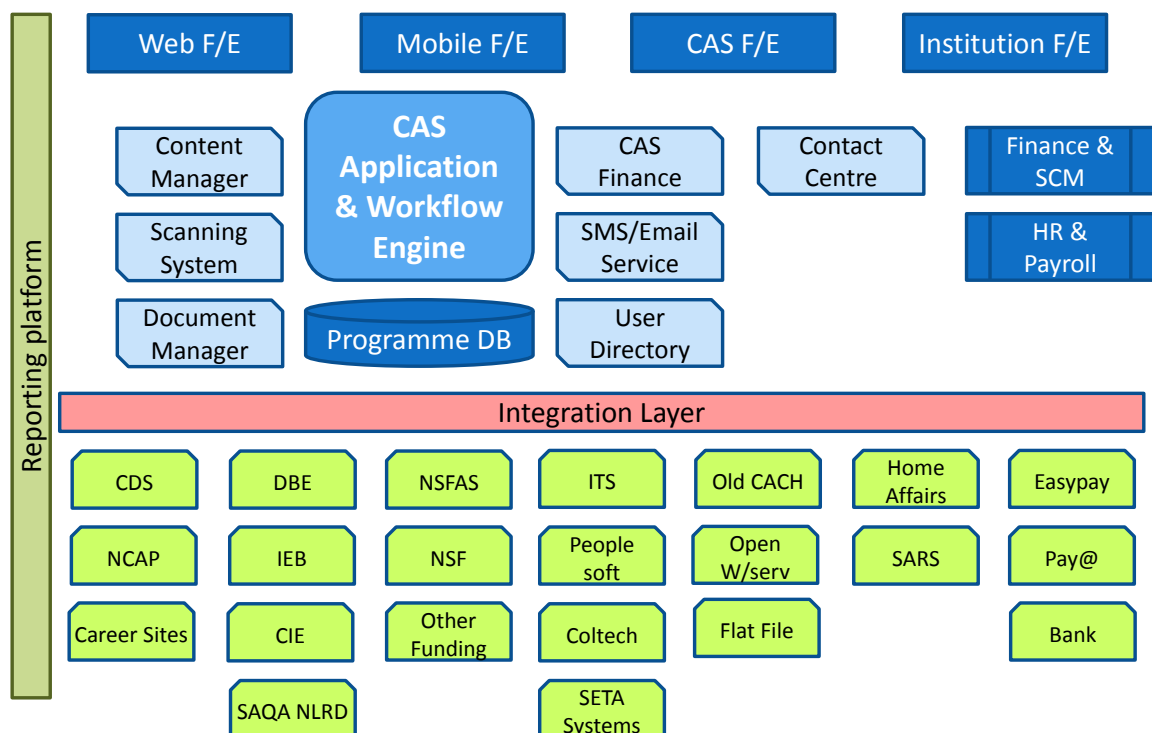
Service Partner	Expected IT Integration	Service Partner Landscape	Architecture Impacts
KZN CAO	No integration expected but opportunity to leverage KZN CAO platform	Custom-developed application handling workflow platform. Being re-written by Computer Specialists	1. Opportunity to leverage components of KZN CAO systems (e.g. DBE & IEB integration, Easypay integration, Payment reconciliation, System flows, Functional requirements, Implementation learnings)
NSFAS	Deep integration relating to application flow	Custom-built on Cordiz workflow platform	1. Web Service architecture for application flow 2. Opportunity for platform leverage
NSF	Integration through NSFAS		
Other Funders	Deep integration relating to application flow	Unknown	1. Web Service architecture for application flow 2. Institution Front End to allow access to CAS data
Dept. of Home Affairs	South African ID validation	Leverage existing Home Affairs web service (possibly leveraging NSFAS)	1. Web Service for ID validation
SARS	Taxable income – may be better to allow funder to do this directly	Leverage existing SARS web service (possibly leveraging NSFAS)	1. Web Service for SARS income validation
DBE	Upload of DBE results, preferably early in “embargoed” state	Detail unknown, but database exists and only need periodic extract of results	1. Results extract and upload
IEB	Upload of IEB results, preferably early in “embargoed” state	Detail unknown, but database exists and only need periodic extract of results	1. Results extract and upload
CIE	Upload of CIE results, preferably early in “embargoed” state	Detail unknown, but database exists and only need periodic extract of results	1. Results extract and upload
NLRD / SAQA	NLRD record for applicant ID	NLRD database exists, but would need web service to obtain NLRD record	1. Web service to obtain NLRD record

Service Partner	Expected IT Integration	Service Partner Landscape	Architecture Impacts
Dept. of Labour	No integration, but possible leverage of Labour Offices and service points	Centralised system, being refreshed 400+ service points, connected centrally through Citrix 60+ Kiosks being rolled out	1. Access CAS Front End through Citrix

3 CAS Application and Integration Architecture

3.1 Architectural Overview

Based on the Service Model and Application Flow previously defined in Deliverable 4.2, and incorporating the implied business requirements from the Operating Model, Business Architecture and Business Processes previously defined in Deliverable 4.4, an Application and Integration Architecture was developed, outlined in the diagram below and with the components further described in later sections of this document.



The Application Architecture consists of a number of components that surround the core Application & Workflow Engine and the Programme Database. The Integration Architecture consists of an Integration Layer that enables effective and efficient data flows to and from the service partners.

3.2 Design Principles

A number of key Design Principles have been defined that underpin the Application Architecture, outlined below

- Comprehensive Academic Programme information on central Academic Programme Database
 - Regarding the Academic Programme – allowing applicants to understand what the programme that is being offered is all about
 - Regarding the Institution offering the Academic Programme
 - Making clear the minimum entrance requirements – this is important to the Applicant to prevent applications that are not suitable for the applicant, but also to enable the CAS and other service partners to provide guidance to applicants
 - Making clear the costs of the Academic Programme – cost is a critical piece of information to Applicants

A Position Paper on such a central National Academic Programme Data Store has been developed by the project and submitted separately to DHET. Irrespective of the adoption of such a National Academic Programme Data Store, the CAS architecture would have to contain a central Academic Programme database.

- Standardised terminology, status and conditions
 - Clearly defined and unambiguous
 - Easily understood by Applicants
 - Consistent across PSET
- Online applications via PC and mobile devices – to support the drive to online applications, an effective Mobile Front End is critical
- Unique identification of applicant and application – critical to enable efficient handling of queries and prevent applications “getting lost”.

3.3 Application Architecture

The CAS Application Architecture consists of a number of components that are further described below.

- **CAS Application & Workflow Engine** – The CAS Application & Workflow Engine is the core of the ICT Architecture
 - It will contain the core business logic and workflow paths, and must be configurable to allow flexibility in business rules and workflow rules
 - It includes the CAS databases. The CAS engine must be hosted centrally and accessible through standard internet protocols.
- **CAS Academic Programme Database** – The CAS Academic Programme Database houses the Academic Programme information against which applicants will make Academic Programme information and selection decisions



- It will contain all Academic Programme information enabling information and selection
- It will be maintained by the Institutions participating in the CAS
- It is recommended that the CAS is the host of a central National Academic Programme Database(s)
- **Front Ends (F/E)** – The CAS Engine is made available to end users through multiple Front Ends, including
 - **Web Front End** consisting of a CAS public website containing information and content available to the general public, and an applicant portal that will be used by Applicants for processing and monitoring applications (and whose access will be restricted to only their data)
 - **Mobile Front End** that provides an alternative, mobile-friendly mechanism for Applicants and other outside, non-privileged users
 - **CAS Front End** that provides the functionality for CAS employees, with access and functionality appropriate to their job function and level of authority. Typically CAS employees will have access to the data of a range of applicants
 - **Institution Front End** that provides the functionality for institution employees, with access and functionality appropriate to their job function and level of authority, and with access restricted to applicants to their institution. Functionality for Institution Front Ends may be differentiated for Educational Institutions, Funding Institutions, Companies and Academic Programme Database Institutions and will provide basic application handling functionality to allow the Institution to use the CAS system to “select” applicants
 - Front Ends must make **provision** for applicants with **disabilities**
- **CAS Supporting Applications** – The CAS Supporting Application provide peripheral functionality used by the core engine, and including
 - **Content Manager** to enable content required by the CAS Application and the Front Ends to be stored and maintained
 - **Scanning Functionality** to enable documents received by the CAS in paper format to be scanned and the stored in the Document Manager
 - **Document Manager** to manage the documents received with applications, either from the Scanning Functionality, or with the online application system (Web F/E and Mobile F/E) or submitted in digital form via email or other form. The Document Manager will need functionality to transform documents to a common format (expected to be PDF) and to split submitted PDFs into multiple documents.
 - **CAS Finance** to manage the financial transaction associated with applications and control that where applicants are expected to pay an application fee, this fee is received, and where application fees are funded by other entities as capitation fees, the correct reconciliation is produced to support claims for such fees.
 - **SMS/Email Service** to manage the communications triggered by the application workflow
 - **User Directory** to manage the user access and authentication



- **Contact Centre** functionality to enable agents to capture call information and/or communication information associated with an enquiry about an application or general enquiry
- **Additional Functionality** - The CAS Web Front End application will also require functionality to assist applicants (and future applicants) with determining academic programmes, for instance:
 - Functionality to allow an applicant to identify academic programmes for which they meet entrance requirements based on their school results;
 - Functionality to allow a future applicant to determine what school curriculum they should follow to enable them to qualify for a particular academic programme; and
 - Functionality to incorporate Academic Ranking systems into the application processes.
- **Reporting Platform** – The CAS Reporting Platform will provide information both for the operation of the CAS itself, but also, and possibly more importantly, provide information to enable Business Intelligence as well as Monitoring & Evaluation
 - The Data Model of the Reporting Platform is critical and must form a critical component of the Detailed Design Phase;
 - The Data Model must incorporate the application data defined in Deliverable 4.2 to enable the effective flow of applications to Institutions; and
 - The Data Model must incorporate the data to enable the Assessment Indicators defined in Deliverable 4.9.

The Detailed Design phase will develop detailed business requirements, functional specifications and workflow designs that will further clarify the Application Architecture above.

3.4 Integration Architecture

The Integration Architecture consists of an **Integration Layer** that will manage the integration between the CAS Application & Workflow Engine and surrounding system. The integration will use predominantly

- **web services** for online integration (e.g. web service between CAS and NSFAS to determine funding eligibility)
- **file based** integration for bulk data interchanges (e.g. DBE results)
 - **Note:** Bulk Upload of results must make provision for subsequent upload of upgraded results
- It is expected that for the institutions, there will be multiple integration types, depending on the systems at the institution.

While it is premature to define detailed Integration Points at this stage (these will be defined in the Detailed Design phase), some preliminary thoughts on the key integration points between

- CAS and Institutions; and
- CAS and NSFAS

are outlined below. In each case, these are envisaged as web services called by the system of one entity to the system of the other entity, based on stages and conditions in the application workflow.

For instance, step 1 of the CAS to Institution web service will be called when the application has reached the stage in the application workflow where it is ready to be submitted to the Institution. The table below then defines

- The stage in the application flow
- The direction of data flow
- The information provided by the entity that initiates the web service
- The information returned by the entity that responds to the web service

CAS / Institution Web Service Integration

Service	Direction	Information Provided	Information returned
1 – Pass on Academic Programme Application & Funding Eligibility	CAS to Institution	CAS Application Data <ul style="list-style-type: none"> • Personal Details • Academic Programme Selection • Results Data • Recognition of Prior Learning Data • Funding Eligibility (where applied to NSFAS) • Accommodation Application • Supporting Documents • Status of Other Applications • Info on previous applications • Application / Update / Cancel 	<ul style="list-style-type: none"> • Acknowledgement of receipt of new application / receipt of update to application / cancellation of application
2 – Update Academic Programme Application Status	Institution to CAS	Academic Programme Offer <ul style="list-style-type: none"> • Status update (Pending / Waitlist / Offer / Regret / Offer Expired) 	<ul style="list-style-type: none"> • Acknowledgement of receipt
3 – Acceptance of Offer	CAS to Institution	Application Acceptance (by Applicant)	<ul style="list-style-type: none"> • Acknowledgement of receipt

Note that the successful execution of the service will trigger CAS communications to the Applicant, indicating status

- Step 1 will trigger a communication that the application has been submitted
- Step 2 will trigger a communication that an Institution has updated the status of the application
- Step 3 will trigger a communication that the acceptance of the offer has been submitted to the Institution

CAS / NSFAS Web Service Integration

Service	Direction	Information Provided	Information returned
1 – Pass on Funding Application & Establish Eligibility	CAS to NSFAS	CAS Application Data <ul style="list-style-type: none"> Personal Details Academic Programme Selection Results Data Household income Data Application / Cancel 	<ul style="list-style-type: none"> Acknowledgement of receipt If application, indicate Eligible or Ineligible, else confirm cancellation
2 – Update Funding Application Status	NSFAS to CAS	NSFAS Funding Outcome <ul style="list-style-type: none"> Status update 	<ul style="list-style-type: none"> Acknowledgement of receipt

3.5 Business Applications

The CAS business applications will provide functionality to manage the business of CAS, namely

- Finance and Supply Chain Management for financial accounting and purchase order management
- Human Resource and Payroll for human resource management and payroll management

Based on the expected size of the operation (about 200 staff at peak expenditure in the region of R120m) and required level of business control (given that a key financial control will be the fee payment reconciliation tools that will be purpose-built for the application handling system), we believe that a mid-size ERP package such as Sage ERP or SAP Business One will be appropriate, in use by many South African mid-size businesses and public entities.

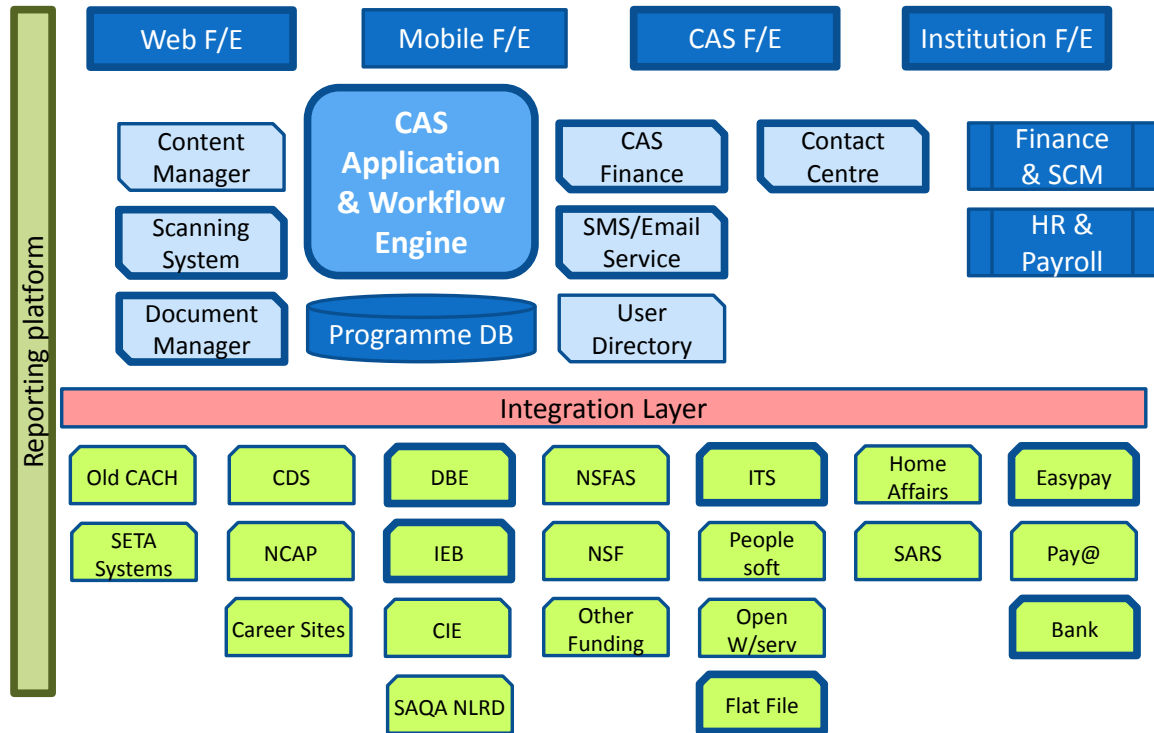
3.6 Technology Components in KZN CAO

The KZN CAO represents an entity, operating in South Africa, offering a service that closely reflects the intent of the PSET CAS, albeit that it services Institutions in a single province rather than on a national basis.

Discussions have been held with the KZN CAO to understand their operating model and their way of business. During these discussions, the KZN CAO indicated that they are developing a new application handling systems platform. A follow-up discussion was held with the developers of this platform, Computer Specialists, during which the project team attempted to obtain details on the future application handling system. The project team was only able to obtain information at a high level, indicating the functional areas of the new system.

Nevertheless, an initial attempt has been made to identify the technology components that are already in the KZN CAO (in their new system) and map these against the proposed application architecture for the PSET CAS, thereby indicating the areas of leverage that could be pursued.

The technology components already in the KZN CAO are highlighted by bold outlines in the diagram below, indicating that the KZN CAO has technology components that cover the core application handling system, as well as integration to a number of service partners.



It is important to note however that while these indicate areas of leverage, this does not necessarily mean that these technology components can be “lifted” from the KZN CAO into the PSET CAS.

3.7 Technology Components in NSFAS

NSFAS is a South African public entity that awards and manages PSET grants and loans to fund higher education studies. It has recently embarked to change its operating model and move towards a student-centric funding model (where previously a significant portion of the operating model was devolved to educational institutions themselves).

As part of the implementation of its new operating model, NSFAS has developed a comprehensive systems platform to manage applications for funding, granting for funding, disbursements of funding and collections of the underlying loans. The NSFAS platform was developed on advanced technology components and represents a significant investment in technology.

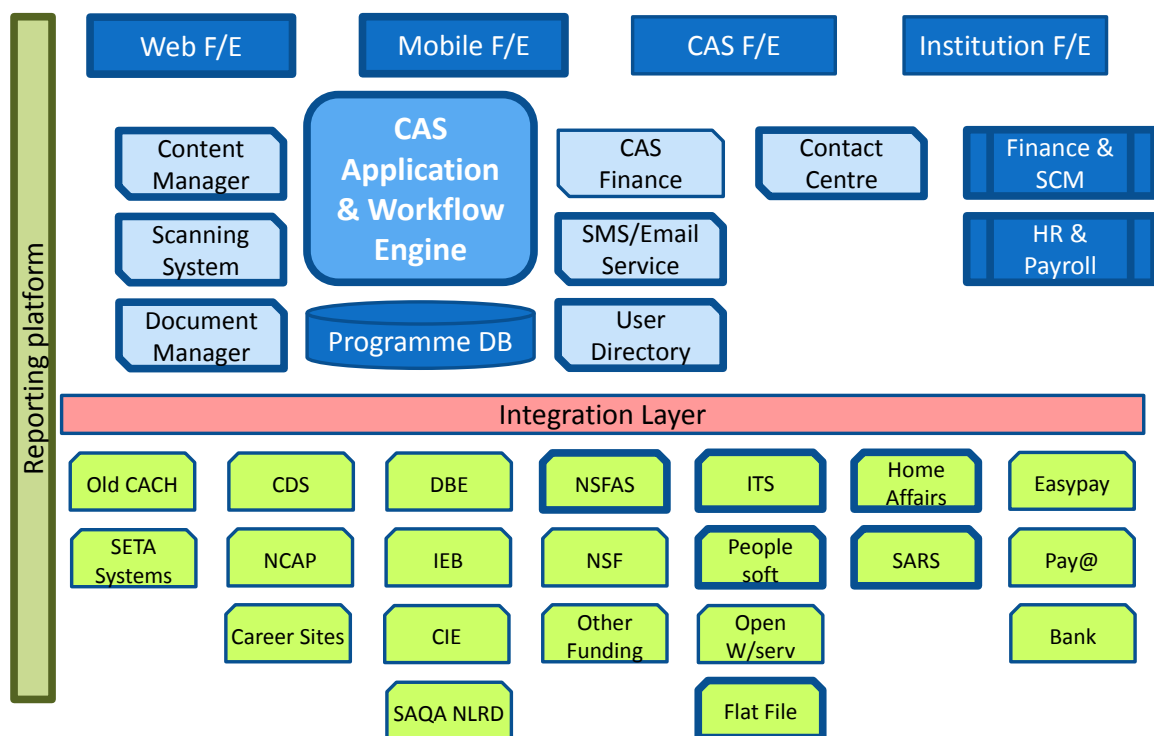
Even before the establishment of the PSET CAS Enterprise Architecture project, the possibility of leveraging the NSFAS platform to develop the CAS platform was raised. This possibility was premised on two key aspects:

- The NSFAS platform consists of an online application system that gathers much of the same information as the CAS application; and
- The NSFAS platform is built around a strong workflow engine, and the CAS would equally need a strong workflow engine.

The project team was able to engage with the NSFAS IT team on a number of occasions to explore these opportunities. During these engagements, it was established that:

1. The application data gathered by NSFAS does indeed conform to the expected application data for the PSET CAS
2. The NSFAS platform contains a number of components that could be leveraged by the PSET CAS

The technology components already in the NSFAS platform are highlighted by bold outlines in the diagram below, indicating that the NSFAS also has technology components that cover the core application handling system, as well as integration to a number of service partners.



It is important to note however that while these indicate areas of leverage, this does not necessarily mean that these technology components can be directly consumed by the PSET CAS – it is expected that significant development would be required to adapt the Front End as well as the workflows to the requirements of the PSET CAS, but this would avoid the investment in the underlying workflow platform.

3.8 Consequences of the Application and Integration Architecture

The CAS Application and Integration Architecture is designed around the principle of seamless transfer of data between CAS, institutions (both educational and funding institutions) and applicants. It is important to note that, in line with the requirements of the POPI Act, applicants will need to consciously permit the CAS to share their data with Institutions, and the CAS will need to ensure that it has agreements in place with these Institutions to ensure that the institutions adhere equally to the POPI guidelines.

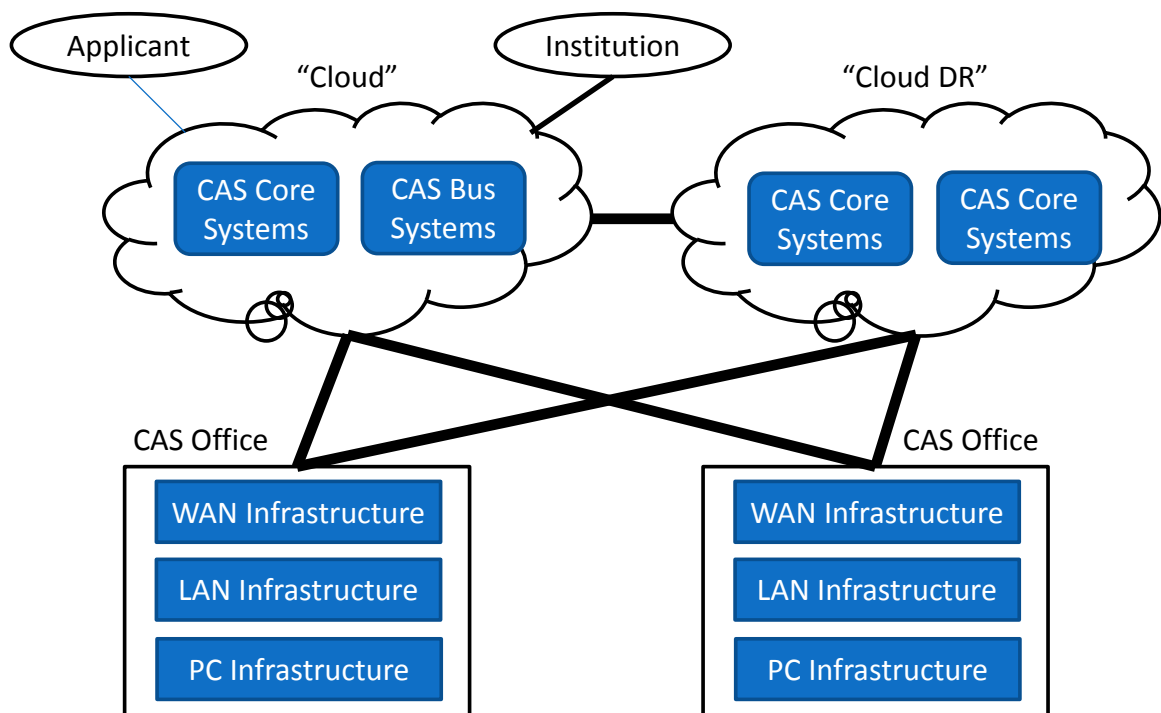
4 CAS ICT Infrastructure

4.1 ICT Infrastructure Overview

To implement the proposed application and integration architecture, an infrastructure platform will be required. As outlined above, it may be possible to leverage components from the KZN CAO and/or NSFAS, and in the case of NSFAS that could include its infrastructure platform. In the case of KZN CAO, its server infrastructure could conceivably be leveraged, but in practice this may be difficult to achieve as the infrastructure would only be available after the PSET CAS has launched.

Current best practice for the types of systems that are envisaged for the PSET CAS dictate that the systems should be hosted in the “Cloud”. Due to the nature of the data that will be hosted on the PSET CAS, a “private cloud” is suggested, meaning that while the systems are hosted in the “cloud”, it is done so with a reputable cloud service provider who can provide the necessary infrastructure, skills and security to ensure that the PSET CAS systems and data are securely hosted. In addition, by hosting on a private cloud, the PSET CAS can be ensured of levels of scalability of processing capacity, storage capacity and internet network access throughout its growth phase. Furthermore, by hosting in the cloud, the hosting service provider can typically also provide Disaster Recovery (DR) services to ensure business continuity on the event of technical or other issues. Lastly, in the case of the CAS Business Systems, it is expected that these can be provided on a “Software as a Service” (SaaS) basis, effectively a software subscription that allows business users to utilise business software that is fully provisioned by the software service provider

As outlined in the previous section, the PSET CAS application environment consists of the core application handling systems and business application systems. Both of these systems can and should be hosted in the cloud, as illustrated in the diagram below.



In the diagram, the CAS Office have local infrastructure in the form of PCs, a local area network (LAN) and wide area network (WAN) connectivity through which CAS office users

can connect to the CAS Core Systems and CAS Business Systems. The WAN connectivity will allow each CAS Office to connect to both the main and the DR instances.

Outside users of the system will connect via the Internet to the CAS Core systems hosted within the cloud using secure access protocols, and leveraging the internet connectivity provided by the cloud service provider.

While a detailed infrastructure requirement assessment would form part of the Detailed Design phase, a preliminary estimate of infrastructure requirements was performed.

4.2 Hosted Infrastructure

The Hosted Infrastructure will include

- Hosting for the CAS Core Systems and the CAS Business Systems, including operational monitoring, backup, disaster recovery
 - We recommend that the CAS Business Systems are procured on a software subscription basis (i.e. on a SaaS basis)
- Hardware is provided by Hosting Service Provider, with ability to scale on demand
- Likely Hardware requirement for CAS Core Systems
 - 4 Virtual Servers with management and support for the operating system and the database system
 - 12 TB Storage System (scalable on demand – may be significantly less if supporting documents are limited)
 - Based on 12 documents at 200KB and 500,000 applicants per year, retained for 5 years (equates to 8TB)
 - Firewall management
 - Active Directory Management
 - Middleware management (for the integration layer)

The Hosted Infrastructure cost estimates for the CAS Core Systems will be based on these requirements

4.3 CAS Office Infrastructure

Based on the expected volumes for the PSET CAS, the following CAS Office Infrastructure requirements are predicted:

- In the CAS Office
 - Personal Computers for staff
 - Laptops for management and specialists
 - 4x Personal Secure Printers (EXCO and HR manager)
 - 1x High Speed Printer per 50 staff
 - 1x High Speed Scanners per 5 scanning Agents



- LAN network
- Wi-Fi network
- WAN Router & Firewall
- Internet & VPN Cloud Connectivity (50MB Fibre if available, else 20MB SDSL/ADSL)
- File Server
- Mail Server
- In the CAS Outreach Office
 - 4 Personal Computers, of which 2 to 3 available to applicants preferably as a kiosk
 - 2 Combination Printer / Scanners
 - LAN network
 - Wi-Fi network
 - WAN Router & Firewall
 - Internet & VPN Cloud Connectivity (4MB ADSL minimum)
- In the CAS Point of Presence
 - Minimum 2 Personal Computers available to applicants, preferably as a kiosk
 - 1 Combination Printer / Scanners
 - LAN and WAN connected
 - Internet Connectivity (4MB ADSL minimum)

The Office Computing Infrastructure cost estimates for the CAS will be based on these requirements

5 Conclusion

The ICT Architecture and Infrastructure presents the expected Technology environment that will be required to support the CAS Business Processes and Organisational Structure. It must be noted however that the detailed business requirements and functional specifications that will be developed during the Detailed Design phase may cause amendments to these proposals.