South Africa Airside Capacity Enhancement Study for Air Traffic Navigation Services

Task 8 Report: Implementation Plan

Metron Aviation, Inc.
45300 Catalina Court, Suite 101
Dulles, VA 20166

26 April 2013

The U.S. Trade and Development Agency

The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project planning activities, pilot projects, and reverse trade missions while creating sustainable infrastructure and economic growth in partner countries.

REVISION HISTORY

Internal Process #	Document Version # Revision History	Approval Date	Modified By	Section, Page(s) and Text Revised
CPS-C011-0412	1.0	12 April 2013	Metron Aviation	Initial version delivered
CPS-C011-0412	2.0	26 April 2013	Metron Aviation	Version 2 delivered
CPS-C011-0412	2.1	30 April 2013	Metron Aviation	Version 2.1 delivered

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

LIST OF ACRONYMS

ACN ....Aircraft Classification Number

ACSA....................Airports Company South Africa

AFT ....Airport Flow Tool

AIP ....Aeronautical Information Publication

ANSP ....Air Navigation Service Provider

ARC ....Aerodrome Reference Code

ATC......................Air Traffic Control

ATCC....................Air Traffic Control Center

ATCT ....Air Traffic Control Tower

ATM.....................Air Traffic Management

ATNS ....Air Traffic Navigation Services

CAA ....Civil Aviation Authority

CAMU..................Central Airspace Management Unit

CAR ....Civil Aviation Regulation

CAT......................Instrument Landing System Category

CATEX ....Categorical Exclusion

CATS……………Civil Aviation Technical Standards

CTOT ....Calculated Take-off Time

EA ....Environmental Assessment

EIS.......................Environmental Impact Statement

F&E......................Facilities and Equipment

FAA......................Federal Aviation Administration

FACT ....Cape Town International Airport

FAOR...................OR Tambo International Airport

FALE....................King Shaka International Airport

IAP ....Instrument Approach Procedure

ICAO....................International Civil Aviation Organisation

LVO ....Low Visibility Operations

NASCOM ....National Airspace Committee

NEPA ....National Environmental Policy Act

NOTAM ....Notice-to-Airmen

OPSCOM ....Operations Committee

PBN.....................Performance-Based Navigation

RET ....Rapid Exit Taxiway

RWY ....Runway

SID ....Standard Instrument Departure

SSI.......................Station Standing Instructions

STAR ....Standard Terminal Arrival Route

TFM ....Traffic Flow Management

TWY ....Taxiway

USTDA ....United States Trade and Development Agency

VFR.....................Visual Flight Rules

1   Introduction

Air Traffic and Navigation Services (ATNS) and Airports Company South Africa (ACSA) have engaged Metron Aviation, Landrum & Brown, and ACA Associates (study team) to conduct a South Africa Airside Capacity Enhancement Study (SA ACES). This report provides the framework for implementing the recommended enhancements for the set of airside capacity enhancements researched in Tasks 1 through 7. The final proposed implementation framework takes into consideration outside influences on the implementation process, such as legal processes, system development processes, and environmental processes.

This implementation plan is the culmination of several months of work by ATNS, ACSA, their stakeholders, and the study team. ATNS and ACSA recognized early on the need to present to its stakeholders an agreed upon roadmap to generate support for the proposed airside improvements. Hence, the key characteristic of the implementation roadmap described in this report is that it is a joint roadmap that considers the dependencies among the enhancements and the need for ATNS and ACSA to work together to address future demand and general inefficiencies. This report is the basis of an eventual final joint roadmap that will lay out the path towards implementation of the capacity enhancements and consider the needs of the ATNS and ACSA stakeholders.

1.1   Traffic Demand Triggers

The study team believes that triggers will play an important role in determining when airport and airspace capacity enhancements need to be made. Indeed, the use of triggers is becoming a best practice at airports because they help stakeholders anticipate future investment needs instead of waiting for demand to exceed capacity. Typically triggers are quantitative measures of demand (e.g., annual, daily or peak hour movements or frequency of peak hours throughout a typical day), which will cause airports to deny operations (at times requested) or cause delays to reach a level that is unacceptable to aircraft operators and the traveling public. Triggers could also be defined based on routinely recorded delay metrics.

A major theme in this report is that certain recommended enhancements produce measureable efficiency benefits in the form of delay reduction or reduced operating time. Therefore, it is important to express the enhancement triggers in the same metric dimension (time) to ensure consistency across enhancement categories. This is not a trivial experiment, as one of the many challenges of airport and airspace planning is that delays do not grow linearly as traffic rises. This is because factors that cause delays frequently interact resulting in exponential delay growth that, if not anticipated, can cause significant problems for aircraft operators, the traveling public, and the local economic catchment areas. Further, the magnitude and nature of aircraft delay is heavily influenced by forecast demand distributional characteristics, such as fleet mix and hourly profiles (among other factors), which are very dynamic and are influenced by aircraft operator strategies.   Comprehensively quantifying the complex and inter-related causalities of delay at future levels of demand is beyond the scope of this study, but a selective analysis can be performed to highlight the impact of demand growth on operational delay for the three study airports.

A preliminary analysis of traffic flow information from the Central Airspace Management Unit's (CAMU) AFT data shows that current nominal operations at FAOR, FALE, and FACT produce average operational delays of on the order of a few minutes per flight. This is due to the distribution of demand throughout the operational day and the application of Calculated Take-off Times (CTOT) so that demand will meet the declared capacity rates: 60-rate for FAOR, 24-rate for FALE, and 30-rate for FACT. Although any reduction in this delay would be favorable, these nominal cases of CTOT application produce delays under "normal" operating conditions, which to some degree are tolerable to aircraft operators.

Since the application of CTOTs can produce some delay, it is likely that additional demand growth will cause additional delay. The purpose of the following selective analysis is to illustrate the impact of demand growth on traffic delay and frame the results in a manner to assist ATNS and ACSA in identifying operational trigger years (i.e., years in which capacity enhancement initiatives must be fully deployed to reduce some, if not all, of the additional delay caused by the traffic growth).

1.1.1 Methodology

The first step in the analysis was to estimate the growth in air traffic movements (ATM), based on available information, including recent demand forecasts prepared by Mott MacDonald. For the purposes of this exercise, forecast traffic growth rates for the year 2020 projection were considered, which is a 50-to-60% increase.[1,2,3] The next step estimated increased traffic at multiple demand growth rates (for 5%, 10%, 15%, etc.) up to 50% to represent potential growth scenarios, which could be considered traffic demand dates, or even trigger years. The growth rates were applied to this study's selected design days for each airport, and more specifically, to each operational hour in the design day.[4] The design days selected for each airport are:

- October 25, 2011 for FAOR
- July 15, 2011 for FALE
- December 4, 2011 for FACT

For each growth rate and at each airport, the new demand was inserted into the operational hour. Next, an airport spacing value derived from the declared capacity rates was calculated (e.g., the 60-rate at FAOR would produce one minute between each operation, which also can be considered as two minutes between any successive arrivals or successive departures).

The next step is to translate the growth of the schedule and the airport spacing value into a delay estimate. Unfortunately, there is great uncertainty in the distribution of the forecast growth in operations throughout the airports' schedules. It cannot be assumed that every new flight will fill a current void in the schedule and produce no additional delay, nor can it be assumed that every new flight will contend with a currently filled slot at the airport and force additional delay. To

---

[1] "Draft Peak Day Forecast Summary – ORTIA." prepared by Mott MacDonald, January 19, 2012
[2] "Draft Peak Day Forecast Summary – King Shaka." prepared by Mott MacDonald, January 24, 2012
[3] "Draft Peak Day Forecast Summary – Cape Town," prepared by Mott MacDonald, January 27, 2012
[4] "SA ACES Design Day Analysis," prepared by Landrum and Brown, December 12, 2012

account for this uncertainty, only half of the airport spacing value is considered for each flight when calculating the additional delay growth; this simple adjustment helps to account for those new flights that would not produce new delays and those that would produce new delays.

1.1.2 Results

Figure 1 shows the trade-offs between traffic growth and average delay per flight. This graphic shows a few major points of interest.

- The right side of the graphic shows that if airports were to accept 50-to-60% traffic increase (estimated by 2020) and the airports still operated under the current capacity rates, then each flight would experience 10 to 11 minutes of increased delay. This increase added to the current delay is three-to-four times higher than that which is currently experienced.
- The left side of the graphic shows that if airports were to accept a 5% increase in traffic (which represents near-term growth), then each flight may experience an additional minute of delay.
- The middle of the graphic illustrates that approximately half-way between now and 2020 each flight may experience four to seven minutes of additional delay without capacity enhancements at the airports. This increase added to the current delay represents approximately double that which is currently experienced.

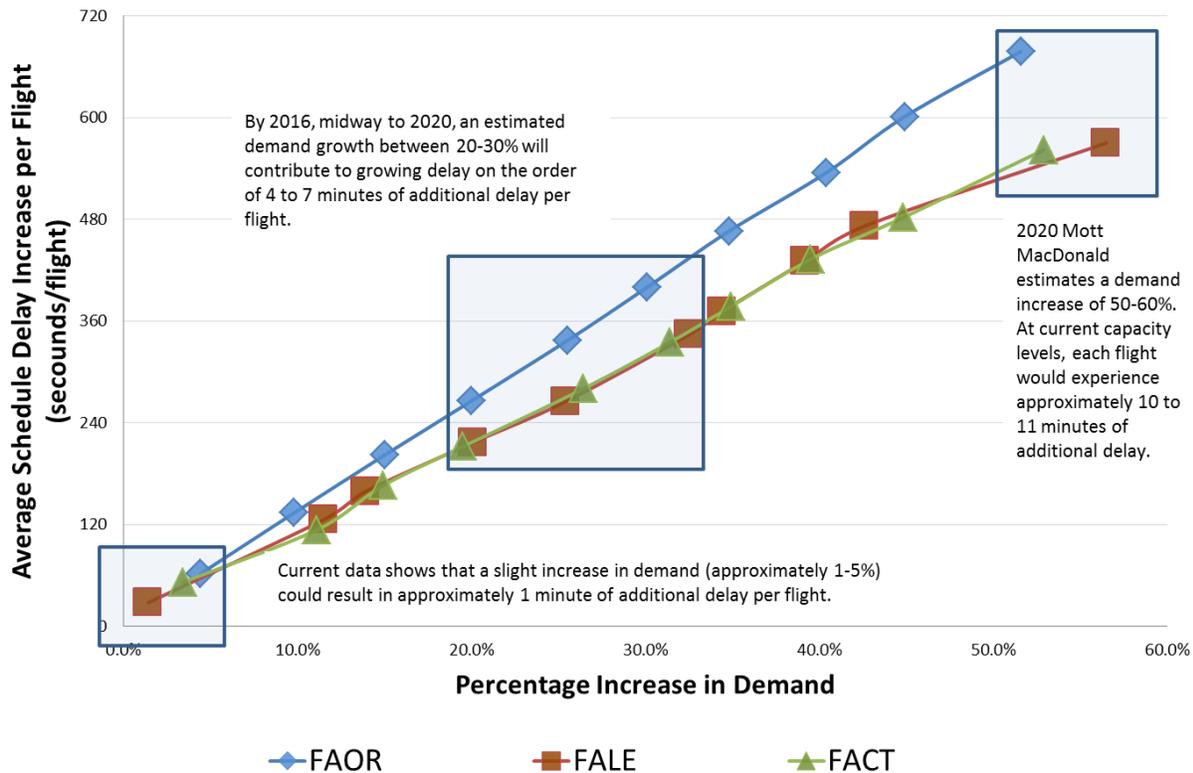## Estimated Delay Increase as a Function of Demand Percentage Growth

Figure 1: Demand Growth will Increase Average Delays at each of the Study Airports

As previously stated, this is not a comprehensive analysis of traffic demand growth and its impacts on delay and should not be used as a substitute for more lengthy research into the detailed aspects of demand growth at the study airports. But this selective analysis does show an estimation of the impacts of the demand growth to help focus some attention on the trigger years in which we can apply some capacity enhancement indicatives to reduce the impacts of traffic growth.

This selective analysis points to the necessity of capacity enhancements to enable traffic demand growth. While the enhancements listed in Section 1.2 will increase efficiency of current operations, they also can support reduced traffic delays while experiencing moderate traffic growth. It is also important to recognize that the recommended enhancements will not mitigate all delays caused by high traffic growth in the far-term. This is represented in Figure 1 by demand increases of approximately 30% or more.

Based on the current forecast, demand is expected to increase by approximately 25% over the next four to five years. Without improvements, delay could increase by four to seven minutes per air traffic movement with the increase in demand, particularly if flights are added during peak hours. Therefore, we recommend that ATNS and ACSA initiate the implementation of these high priority initiatives to reduce the impacts of near-term demand growth.

1.2 Summary of Efficiency Groups

The efficiency groups shown in Table 1 are used throughout this document to communicate the proposed implementation plan for the proposed airside capacity enhancements. The columns in Table 1 provide the reader with an understanding of the specific elements of the group and the location of a more detailed description within this document. The "Capacity Enhancement Category" is the recommended enhancement. The "Impact Area" is a designation of what segment of operations will be affected, be it "Airspace" for changes to airspace operations and procedural changes or "Airside" for changes to airside operations or physical changes to the airfield layout. The "Candidate Capacity Enhancement Initiative" specifies more detail for the "Capacity Enhancement Category" when multiple initiatives contribute to the overall enhancement.

Table 1: Grouping of Airside Capacity Enhancements

ID	Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative
1	Runway/Taxiway Utilisation Focus for Greater Throughput	Minimum required separation on final approach	Airspace	• Apply Minimum Authorised Separation on Final • Reduce Minimum Separation
		Addition of RETs	Airside	• Add RETs to RWY03L/21R (FAOR) • Add RETs to 03R/21L, refine Echo, and add additional RET (FAOR) • Add RETs (Rwy24) for direct access to Alpha & Bravo apron gates (FALE) • Realignment of Runway Exits (FACT)
		Near-term Implementation of Master Plan	Airside	• Add extended taxiway pavement at the end of RWY03L (FAOR)

ID	Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative
2	Airfield Operational Efficiencies	Pilot Reaction Time (PRT)	Airspace	Readiness for Imminent Departure (Improved Pilot Reaction Times)
		Increase Holding Point areas and frequency	Airside	- Multiple Departure Line-up Queues - Multiple Intermediate Departure Holding Points - Add CAT I hold lines and allow CAT I holds pre-departure - Parallel By-Pass Taxiway (FACT)
		Intersection Departures	Airspace	Intersection Departures
3	Efficient Runway & Arrival/ Departure Capacity Utilisation	Departure Sequencing	Airspace	Departure Sequencing
		Performance-Based Navigation	Airspace	- Performance-Based Standard Instrument Departure - Performance-Based Navigation
4	Efficiency & Predictability in Taxiway Utilisation	Standard Taxi Routes	Airside	Standard (Coded) Taxi Routes
5	Balancing of Arrival/Departure Demand	Arrival/ Departure Balancing	Airside	- Arrival/Departure Balancing - Increase mix ops/arrivals on RWY03L/21R (FAOR)
6	Updates to Airport Flow Tool for Better Airport/Airspace Management	Airspace Review and Redesign	Airspace	- Airspace Review and Redesign - Modify Airport Flow Tool (AFT) to do better airspace management, GDPs, AFPs
7	Efficiencies Based on Conditional Clearances	Conditional Clearances	Airspace	Conditional Clearances
8	Peak Demand/Non-Std. Ops. Performance Limits & Traffic Management	Limiting Operations During Periods of Day	Airspace	- Limit Operations during Peak Periods - Limit Operations of Non-Standard Performance

ID	Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative
9	Airfield & Airspace Slot Optimisation	Slot Optimisation and CTOT Compliance	Airspace	• Slot Optimisation • CTOT
10	Traffic Management Coordination	Supervisory staff in ATCCC (Traffic Management Coordination)	Airspace	• Supervisory staff in ATCCC • Tower Coordinator • Traffic Management Coordination
11	Airspace/Airport Demand Prediction Awareness	VFR traffic included in traffic demand predictions	Airspace	Use historical VFR demand predictions, or restrict VFR traffic
12	Low Visibility Operations	Low Visibility Operations	Airspace	Review Low Visibility Operations

2 Implementation

2.1 Standard Implementation Tasks

The study team identified a standard set of implementation tasks that generally apply to the recommended airside capacity enhancements. It is recognized that some tasks will not apply to some enhancements, and that is noted where appropriate. Likewise, the duration of each task will vary by enhancement, and is reflected in the joint roadmap provided in the form of a Gantt chart in Section 2.2.6.

The implementation process for enhancements should be initiated when the activity growth curve intersects the advance time required for the particular enhancement (Typically 12-18 months in advance of need). An annual review of activity triggers relative to expected capacity and delay metrics should be conducted at the location of each enhancement to determine the necessary timing to initiate the implementation cycle for each initiative. It is recommended that ATNS and ACSA use the following list of tasks as guidance for enhancement implementation:

1. Planning
2. Environmental Approval
3. Plan of Finance
4. Design
5. Permits
6. System Procurement
7. Procedure Development
8. Policy and Regulation Changes
9. Construction
10. System Installation
11. System Testing
12. Training
13. Charting
14. Communication

The following sections describe each implementation task and its application to the airside enhancement initiatives. Where applicable, it is noted if the task is specific to the airport or airspace.

2.1.1 Planning

The next four steps are common to airspace and airport planning activities for the implementation. Airspace- and airport-specific steps are contained in 2.1.1.1 and 2.1.1.2.

- Using activity forecasts, determine the likely date at which capacity or efficiency would be compromised due to increase in delays or demand.
- Preparation of a benefit-cost analysis

- Determine the advance time required for implementation based on date at which the demand trigger is expected to be achieved.
- Set a target date for regular review and confirmation of activity growth to capacity impacts.
- In some cases, it may be prudent to perform simulation analysis of individual or multiple improvements to confirm expected performance metrics and provide a solid basis to proceed with the planning and implementation process.

2.1.1.1 Airspace Planning

- Appropriately designate the airspace according to the air traffic services to be provided.
- Establish safety measures for the coordination of civilian and military airspace.
- Designate applicable restricted and reserved airspace.

2.1.1.2 Airport Planning

- Determination of planning criteria, such as aircraft design code based on International Civil Aviation Organisation (ICAO) design guidelines for defining the Aerodrome Reference Code (ARC) and the Aircraft Classification Number (ACN).
- Preparation of detailed planning documents, including updating the master plan if necessary
- Development of updated taxiway nomenclature plan for new Rapid Exit Taxiways (RET) and other taxiways that required new signage and marking
- Development of design criteria to serve as the basis of design.
- Incorporate detailed plans into the Airport Layout Plan for Agency approval

2.1.2 Environmental Approval

Environmental approval requires a review of the environmental impacts of the proposed enhancements. The general process is applicable to proposed airspace and airport enhancements and is illustrated in Figure 2, which is based on US National Environmental Policy Act (NEPA) guidelines, but can be adapted to South African environmental policy. The subsequent subsections describe any specific points regarding the SA ACES recommended enhancements.
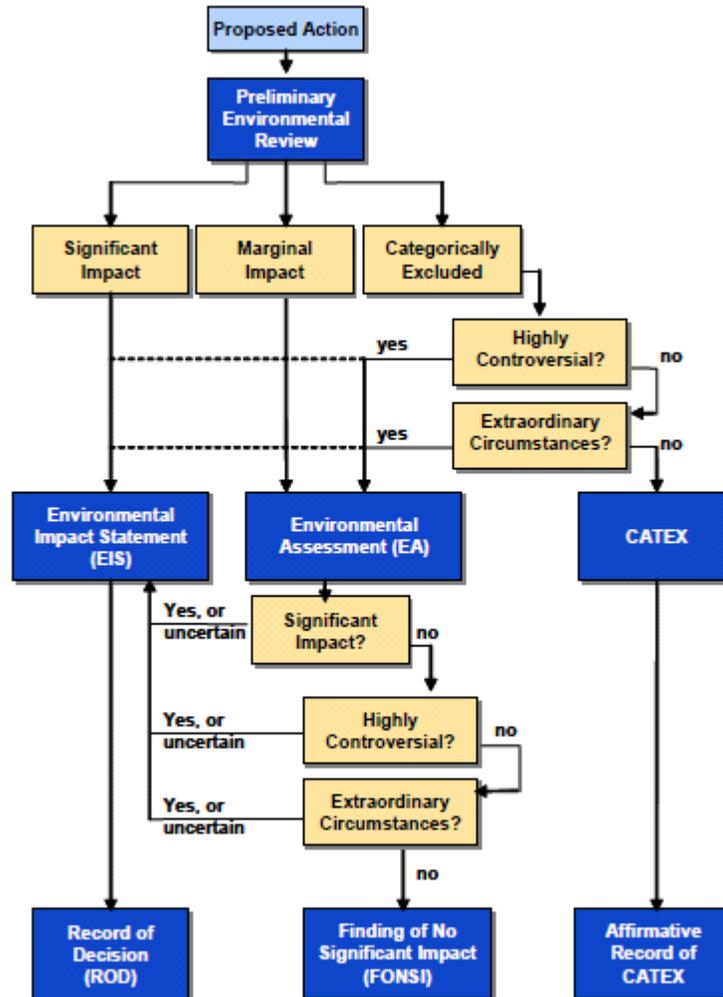
Figure 2: Example of Environmental Impact Process[5]

- The Proposed Action is the proposed airspace design or redesign action
- A Preliminary Environmental Review is used to determine the potential extent of the environmental impacts of the proposed action. This step typically results in one of these three outcomes:
  - o Categorical Exclusion (CATEX) – No further environmental review required
  - o Environmental Assessment (EA) – Considered an appropriate level of review. This will result in a Finding of No Significant Impact or lead to an EIS.
  - o Environmental Impact Statement (EIS) – Proposed action has potential for significant environmental impact.
- Develop a public record of decision.

---

[5] FAA Airspace Management Handbook, Version 2.1, May 2004.

2.1.2.1 Airspace

- Some of the recommended airspace changes may result in changes to noise exposure, so a noise analysis may be required to compare any changes.

2.1.2.2 Airport

- The infrastructure projects recommended herein are likely eligible for a categorical exclusion from detailed environmental processing given their limited scope. Compliance with the specific process requirements will be required in accordance with ACSA criteria
- In some cases it may be necessary to assess the cumulative impacts of multiple improvements anticipated to be implemented in a given time period.

2.1.3 Plan of Finance

This step is common for airspace and airport implementation. Most of the procedural enhancements will not involve capital expenditures; for these, implementation and operational costs should be included in regular planning and budgetary processes. The airport infrastructure projects should be included in the regulatory five year capital budget and factored into ACSA's existing funding strategy.

- Determine funding sources.
- Secure funding.

2.1.4 Design

This section describes the general process for the design of airspace and airport enhancements.

2.1.4.1 Airspace

Airspace changes generally fall into one of the following sets of actions: sector changes, route changes, restrictions changes, or new procedures (SIDs and STARS, PBN procedures). This section only refers to the first three. The new procedures case is covered in Section 2.1.9.

- Characterize the airspace problem by identifying the issues, stakeholders, and potential benefits of mitigation.
- Conduct initial evaluation of airspace problem.
- Conduct airspace study, if necessary. In this step, the airspace design team should define metrics, design scenarios, build models, and carry out simulations.
- Conduct environmental study (2.1.2).
- Summarize and present results, and make recommendations.

2.1.4.2 Airport

The design process for airport infrastructure improvements will abide by current ACSA procedures, which typically include the following steps:

- Issue Design Tender if necessary/Selection of design team.
- Execute detailed design
  - Schematic Design (approximately 30% design)

o Design Development (approximately 60% design
o Construction Documents (100% design)
- Prepare detailed cost estimates.
- Prepare construction/operations plans.

2.1.5 Permits

Construction permits are only required for airport changes and should be secured from relevant agencies.

2.1.6 Construction

- Bid construction project
- Award contract and give notice to proceed
- Construct taxiway enhancements

2.1.7 System Procurement

In general, system procurement activities focus on identification of the sources for development of the system, and the award and administration of contracts. The following steps apply to airspace and airport changes. Airspace- and airport-specific steps are described in 2.1.7.1 and 2.1.7.2.

- Conduct a market analysis to initiate stakeholder involvement.
- Develop procurement plan and strategy.
- Conduct initial cost estimates.
- Review applicable guidance and principles.
- Develop source selection planning
- Screen and/or communicate with potential offerors
- Evaluate submissions and award procurement

2.1.7.1 Airspace

- Update current Airport flow Tool (AFT) or procure new traffic flow management (TFM) and departure sequencing tools.

2.1.7.2 Airport

The procurement of systems and equipment related to airfield infrastructure improvements are typically included in the design and construction process and may include the following:

- Change/install required runway/taxiway centerline or edge lights,
- Procure new taxiway signage, if necessary.

2.1.8 System Installation

The system installation process will typically follow system procurement and system development, so it is assumed that system development has taken place. After the system is acquired, the following steps are shared for all enhancements.

- Train stakeholders in preparation for installation.
- Conduct pre- and post-installation testing (2.1.11).
- Prepare installation site and install system (2.1.8).

2.1.8.1 Airspace

- Install new systems in ATNS and ACSA facilities according to their policy and regulations.

2.1.8.2 Airport

- Install required signage, marking and lighting (and other systems as applicable) to be incorporated into the design and construction process.

2.1.9 Procedure Development

New procedures are included in the recommended set of capacity enhancements. The processes for implementing airspace and airport enhancements are described below.

2.1.9.1 Airspace

- Conduct analysis of current airspace to assess the impact of the proposed changes
- Conduct the appropriate level of safety assessment based on the type of procedures e.g., Standards (separation), air traffic management (ATM) procedures (methods), Regulatory (equipage requirements and access limitations) and Flight (SIDs, STARs, IAP, airways/fixes).
- Conduct data analyses and modeling.
- Conduct environmental surveys.
- Develop required documentation.
- Design and develop charts (2.1.13).
- Train stakeholders (2.1.12).

2.1.9.2 Airport

- Establish ATC procedures for hold pads.
- Make potential adjustments to standard taxi routes.
- Train stakeholders (2.1.12).

2.1.10 Policy & Regulation Changes

The steps for implementing policy and regulation changes are shown below. The airspace and airport changes share the need for Civil Aviation Authority (CAA) coordination.

2.1.10.1 Airspace

- Update SSIs and AIP where applicable.
- Ensure compliance with ICAO regulations.
- Slot optimization system changes.

2.1.10.2 Airport

- Ensure compliance with Annex 14 with the ICAO Convention on Civil Aviation

2.1.11 System Testing

System testing requires that test requirements be defined and that a test team be formed for each system undergoing testing. Testing, along with training and other related tasks, is often conducted as part of the Operational Readiness phase of the project to facilitate the efficient transition from implementation to operation.

2.1.11.1 Airspace

- New software systems must be tested to ensure successful integration with other tools.

2.1.11.2 Airport

- Testing of the lighting control panel in the ATCT for new centerline and edge lighting, if required

2.1.12 Training

- Pilot notification
- Training for pilot, air traffic controllers, and flow managers
- Training for airport operations specialists (including driver training)

2.1.13 Charting (Publish Charts)

- Notice-to-Airmen (NOTAM) during construction
- Updated Jeppesen Charts
- SA- AIP
- Civil Aviation Regulations (CAR) and Civil Aviation Technical Standards (CATS)

2.1.14 Communication

The communication task is one of the most important pieces of implementation. This task should begin at the inception of the project and continue through project close-out. Effective communications should increase the chances of conducting a successful implementation process. All stakeholders must be fully engaged in the implementation process. The process for how communication should occur is described below in more detail and applies to airspace and airport changes.

- Consult existing or create appropriate stakeholder groups early in the process
- Present initiatives to the National Airspace Committee (NASCOM) and Operations Committee (OPSCOM) as appropriate
- Identify opportunities at stakeholder meeting
- Communicate study groups' recommendations to all stakeholders and regulators
- Provide stakeholder notice of intention to pursue financially justified projects
- Review operational performance on annual basis

Figure 3 illustrates a notional timeline for executing the tasks described in sections 2.1.1 through 2.1.14. The actual duration of each task is dependent on the specific enhancement but the sequence of events will generally be the same.
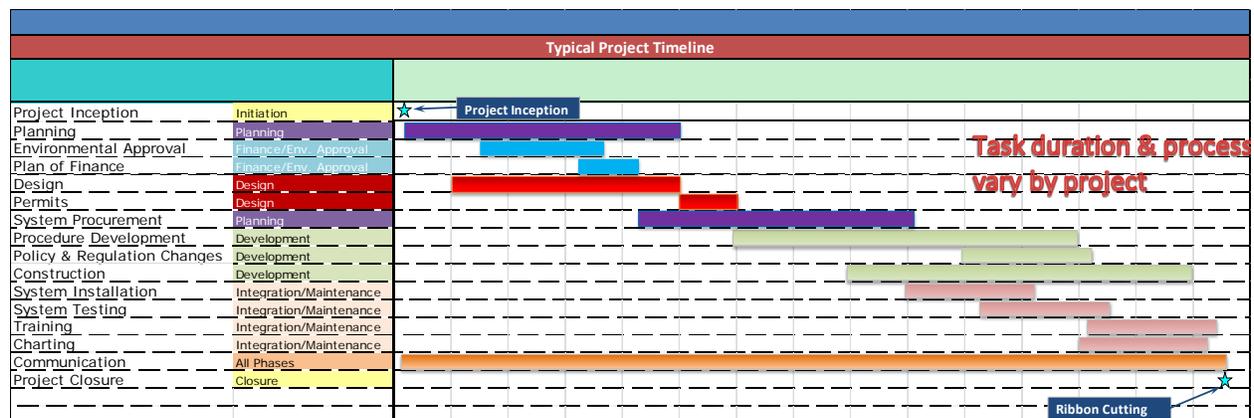

Figure 3: Notional Implementation Timeline

2.2 Proposed ATNS & ACSA Roadmap

ATNS and ACSA requested a joint roadmap that will assist in planning for forecasted demand and for the implementation of future airside enhancements. The roadmap also provides a plan for meeting ATNS and ACSA goals and for communicating the goals and the path to achievement to other stakeholders. This section describes the considerations that went into developing the joint roadmap and presents the initial joint roadmap. Several characteristics were considered in the development of the roadmap.

2.2.1 Dependencies

The study team looked at the dependencies among the enhancements and efficiency groups. The enhancements have been aggregated based on the similarities in operational usage. In some cases, the dependencies among enhancement initiatives are accounted for within the efficiency grouping. However, the study team also attempted to identify dependencies among efficiency groups.

The ability to fully achieve the benefits of many of the recommended enhancements requires the implementation of both airport and airspace/ATC initiatives. Accordingly, the implementation of many of the improvements as stand-alone initiatives without the complementary and dependent initiatives will not yield the maximum operational benefit or predicted capacity increase. The organization of recommended initiatives into efficiency groupings accounts for these dependencies.

2.2.2 Priorities and Schedule

The study team considers all of the recommended enhancements to be high priority based on the results of Task 2, Technical Analysis, and discussions with ATNS and ACSA. It should be noted that a series of other initiatives were studied in Task 2, which provide the opportunity for added capacity enhancement, but were not recommended for near-term implementation based on the

benefit-cost analyses performed therein. The other initiatives were considered as potential long-term opportunities but not recommended for near-term implementation because the expected benefits would not likely justify the investment within a reasonable period of time given the current demand forecast, nor would they fit into the airports' current Master Plan. Based on the study results for Tasks 1-7, the team recommends implementation of the suggested capacity enhancement initiatives to maximize the overall benefits of the proposed enhancements relative to their expected costs, and according to a nominal schedule. The recommended task sequencing is driven by the need to:

- Balance the capacity of the airside and airspace components of each airport;
- Consider the full spectrum of traditional and leading edge solutions;
- Consider infrastructure, procedures, systems and Facilities & Equipment (F&E);
- Strive to minimize capital expenditures and operational expenditures;
- Focus on low-cost initiatives for the near-term;
- Provide input for the next submission of the ATNS/ACSA five- to ten-year budget for the period beginning in 2014-2015.

The task sequence also considers existing and future demand characteristics, including the distribution of demand and the projected aircraft fleet and related performance features/capabilities.

2.2.3 Risks

As with any changes to airside operations, there are inherent risks that should be considered in the implementation plan. Specifically, this study recommends enhancements to procedures, technologies, and airport infrastructure, each of which has its own set of risks.

Implementation of procedural enhancements may be hindered by the regulatory, policy, and stakeholder processes. Changes to procedures may require approval at high levels of government and industry and environmental reviews, which may take a significant amount of time. Therefore, it is important to mitigate as many risks as possible during the design phase. The roadmap assumes a sufficient amount of time for procedural enhancements based on industry best practices, which of course may differ from South African implementation times.

Implementation of new technologies faces risk from poorly defined, missing, or infeasible requirements, and unexpected technology failures. This road map attempts to consider these unknowns, but the roadmap may change as more details are provided to this plan.

Airport infrastructure enhancements are hindered by weather, the availability of construction materials, construction approval processes, and environmental reviews, to name a few. The planning, construction, and permitting phases consider these risks.

Finally, aviation demand could increase more rapidly or more slowly than forecast based on local and global economic conditions and other related factors, which will also influence the timing and need for each of the recommended initiatives. The use of demand triggers for each of the initiatives with advance lead time will help mitigate such risk.

2.2.4 Benefits

This study has identified several potential benefits of the recommended enhancements, should they be implemented. Potential benefits should be thoroughly evaluated to refine the point at which implementation is practical. High level benefits of the proposed enhancements are as follows.

- Increased throughput
- Increased efficiency
- Increased fuel savings
- Reduced emissions
- Fewer flights being delayed into noise sensitive nighttime hours
- Increased predictability
- Reduced delay
- Reduced controller/pilot workload
- Reduced staffing levels
- Increased revenue

2.2.5 Implementation Groups

It has been previously described in the Task 6 report and in this report that most of the capacity enhancements cannot be implemented in isolation. It is suggested that the most effective way to implement the capacity enhancements is to categorize them into four smaller groupings of related enhancements. This is done so that the most effective joint implementation can be carried out by ATNS and ACSA. Gaining the maximum increase in capacity will in most cases require the simultaneous implementation of capacity enhancements within the tabled groupings. There may even be the requirement for simultaneous implementations across the groupings to achieve the quickest capacity and efficiency gains. The new groups are as follows:

2.2.5.1 Arrival Capacity Improvements

This group contains enhancements which essentially increase the arrival throughput of the runways at the study airports. Many of the enhancements in this grouping could supply minimal capacity enhancement if implemented in isolation. For example, ACSA could build the recommended RETs, however, without reduced separation on final approach, there would be no extra throughput and capacity gains. These two enhancements are dependent on each other to gain significant capacity gains. RET improvements are not only an essential enhancement related to other recommendations in the Arrival Capacity Improvements group, but most are also identified in the Airport Master Plans for FAOR and FALE.

Another example of concurrent implementation is the implementation of PBN approaches which would contribute to capacity growth; however, if there is not enough capacity on the ground to cope with the greater throughput of traffic in the TMA, the capacity gain would be lost.

It is recommended that should there be demand for more arrival slots, more arrival slots could be allocated in a given period instead of limiting arrival capacity to 30 (FAOR). The same would apply if there was a greater departure demand. However, for that to be effective, the recommended enhancement of increasing mixed operations on the runways (using both runways for arrivals and departures) at FAOR would need to be implemented.

2.2.5.2 Departure Capacity Improvements

This group contains enhancements which essentially increase the departure throughput at the study airports. As described in the Arrival Capacity Enhancements group, some enhancements can be implemented immediately – PRT for example, which will bring about some efficiency gains. The most effective gains will be obtained if the enhancements are implemented concurrently.

ACSA and ATNS could implement all the recommended enhancements in this group; however, if pilot reaction times are overly long, many of the gains will be negated by extensive ROTs on departure.

ACSA may supply multiple holding points so as to tactically manipulate departures for optimal throughput; however, if pilots or aircraft operator procedures require full length departures for all flights, this enhancement will be negated. Moreover, the additional holding points will be negated if the SIDs do not allow for reduced release times for departing traffic. Therefore, it is required to develop effective PBN departures concurrently. In addition, the ability to fully achieve the benefit of this and other related initiatives may require a pilot education program to ensure comprehensive awareness of the operational opportunity.

A significant enhancement in this group is the implementation of a Pre-Departure Sequencer. This tool optimizes the departure sequence taking into consideration aircraft readiness, gate allocation, variable taxi time, etc. Without the infrastructure changes and cooperation of all stakeholders, it will not be as effective.

The requirement to use both runways at FAOR when there is greater demand for either arrivals or departures also needs to be concurrently implemented so as to optimize implementation of PBN departures.

2.2.5.3 Overall Capacity Improvements

This group contains the LVO capacity enhancing initiative only. The restrictive nature of the current LVOs does not require implementation of the other enhancements should studies reveal that separations standards can be reduced during LVO. For this reason the recommendation to investigate reduction in separation during LVO is kept separate. Currently, the LVO procedures are very restrictive and it is recommended that additional study is undertaken to discover improved procedures. New, less restrictive procedures could be adopted to enable the operations during adverse conditions. Some of these procedures may include redesign of SIDS and STARS and "go-around" procedures. While the LVO enhancement recommendation is grouped on its own, it is apparent that it has dependencies on other capacity enhancements.

2.2.5.4 Overall Efficiency Improvements

In contrast to the Overall Capacity Improvements group, this last grouping of Overall Efficiency Improvements does not lead to direct capacity gains; however, it is believed that they individually and accumulatively will lead to delay reduction and efficiency gains which should ultimately contribute to capacity gains. There are capacity enhancements within this group which could be implemented almost immediately leading to efficiency gains, such as Slot

Optimization, Traffic Management Coordination and VFR Flight Planning for all flights at FACT.

A significant capacity gain recommendation in this grouping could be the limiting of certain operations during peak periods (best-equipped, best-served). However, for that to happen, the slot allocation systems must be updated to accommodate allocation of slots to specific aircraft, and stakeholder approval is needed. In addition, significant regulatory and policy related issues would have to be addressed.

Using Table 1 as a starting point, two columns were added to that table to designate the implementation group and the time to implementation. The implementation groups are described above. The time to implementation is defined as the minimum amount of time needed to implement the enhancement assuming that all approvals (e.g. funding/budget, legal, etc.) have been received. The resulting table is shown in Table 2.

Table 2: Proposed Implementation Groupings

Implementation Group	ID	Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative	Time to Implementation
Arrival Capacity Improvements Estimated Arrival Capacity increase FAOR: 3 - 5 FALE: 2 - 4 FACT: 2- 3	1	Runway/Taxiway Utilisation Focus for Greater Throughput	Minimum required separation on final approach	Airspace	• Apply Minimum Authorised Separation on Final • Reduce Minimum Separation	FAOR-6 months FALE-18 months FACT-18 months
			Addition of RETs	Airside	• Add RETs to RWY03L/21R (FAOR) • Add RETs to 03R/21L, refine Echo, and add additional RET (FAOR) • Add RETs (Rwy24) for direct access to Alpha & Bravo apron gates (FALE) • Realignment of Runway Exits (FACT)	2-3 years
			Near-term Implementation of Master Plan	Airside	• Near term implementation of the extension of taxiway Golf for Rwy24 (FALE)	2-3 years
	3	Efficient Runway & Arrival/ Departure Capacity Utilisation	Performance Based Navigation	Airspace	• Performance-Based Standard Instrument procedures (PBN)	3 years
	5	Balancing of Arrival/Departure Demand	Arrival/ Departure Balancing	Airside	• Arrival/Departure Balancing • Increase mix ops/arrivals on RWY03L/21R (FAOR)	1.5 years

Implementation Group	ID	Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative	Time to Implementation
Departure Capacity Improvements Estimated Departure Capacity increase FAOR: 3 - 5 FALE: 2- 3 FACT: 2 -3	1	Runway/Taxiway Utilisation Focus for Greater Throughput	Near-term Implementation of Master Plan	Airside	• Add extended taxiway pavement at the end of RWY03L (FAOR)	2-3 years
	2	Airfield Operational Efficiencies	Pilot Reaction Time (PRT)	Airspace	Readiness for Immediate Departure (Improved Pilot Reaction Times)	3 months
			Increase Holding Point areas and frequency	Airside	• Multiple Departure Line-up Queues • Multiple Intermediate Departure Holding Points • Add CAT I hold lines and allow CAT I holds pre-departure (FALE, FACT) • Parallel By-Pass Taxiway (FACT)	2-3 years for design & construction (<6 months for procedural and hold lines)
			Intersection Departures	Airspace	• Intersection Departures	3 months
	3	Efficient Runway & Arrival/ Departure Capacity Utilisation	Departure Sequencing	Airspace	Departure Sequencing (PDS)	2-3 years
			Performance-Based Navigation	Airspace	• Performance-Based Standard Instrument procedures (PBN)	3 years
	5	Balancing of Arrival/Departure Demand	Arrival/ Departure Balancing	Airside	• Arrival/Departure Balancing • Increase mix ops/arrivals on RWY03L/21R (FAOR)	1.5 years

Implementation Group	ID	Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative	Time to Implementation
Overall Capacity Improvements Will improve arrival capacity during LVO	12	Low Visibility Operations	Review of Low Visibility Operations	Airspace	• Specific studies of reducing separation standards during Low Visibility Operations	1-1.5 years
Overall Efficiency Improvements No direct capacity increase; however, efficiency gains, which will enable capacity increases.	4	Efficiency & Predictability in Taxiway Utilisation	Standard Taxi Routes	Airside	• Standard (Coded) Taxi Routes	1.5 years
	6	Updates to Airport Flow Tool for Better Airport/Airspace Management	Airspace Review and Redesign	Airspace	• Airspace Review and Redesign • Modify Airport Flow Tool (AFT) to gain better airspace management, GDPs, AFPs	3 years
	7	Efficiencies Based on Conditional Clearances	Conditional Clearances	Airspace	• Conditional Clearances	6 months
	8	Peak Demand/Non-Std. Ops. Performance Limits & Traffic Management	Limiting Operations During Periods of Day	Airspace	• Limit operations during Peak Periods by aircraft category • Limit Operations of Non-Standard Performance (Best equipped best served)	> 2 years
	9	Airfield & Airspace Slot Optimisation	Slot Optimisation and CTOT Compliance	Airspace	• Slot Optimisation	.5-1 year

Implementation Group	ID	Efficiency Group	Capacity Enhancement Category	Impact Area	Candidate Capacity Enhancement Initiative	Time to Implementation
	10	Traffic Management Coordination	Supervisory staff in ATCCC (Traffic Management Coordination)	Airspace	• Supervisory staff in ATCCC • Tower Coordinator • Traffic Management Coordination	1.5-2 years (3-6 months for TMC)
	11	Airspace/Airport Demand Prediction Awareness	VFR traffic included in traffic demand predictions	Airspace	Use historical VFR demand predictions, or restrict VFR traffic	1.5-2 years

As noted earlier, the study team is aware that there are instances where individual enhancements may be implemented outside of their efficiency grouping. For example, ATNS and ACSA may consider implementing the following enhancements outside of the efficiency groupings:

- Review of Low Visibility Operations (Efficiency Group 14)
- Pilot Reaction Times (Efficiency Group 2)
- Intersection Departures (Efficiency Group 2)
- Airspace review and re-design (Efficiency Group 6)

This list is not necessarily complete, as circumstances may indicate that other enhancements could be implemented outside of the recommended efficiency groupings.

2.2.6 Joint Roadmap

Finally, the proposed joint airside capacity enhancement roadmap is illustrated in Figure 4 to provide an indicative schedule for the implementation of the recommended near-term enhancements. The study team used the second quarter of 2013 as an overall starting point for implementation given that all of these enhancements are considered near-term enhancements. The end time is the second quarter of 2016. However, the start time can be modified as needed. The roadmap breaks down each of the four implementation groups into specific efficiency groups and capacity enhancement categories. As noted in Table 2, the time to implementation is used to specify the duration. The total duration for each implementation group is shown by the heavy black bars, which includes each of the actions identified in Section 2.1:

- Arrival Capacity Improvements – 785 days
- Departure Capacity Improvements – 817 days
- Overall Capacity Improvements – 180 days
- Overall Efficiency Improvements – 785 days

The colored bars are defined as follows:

- Blue – Primary responsibility for implementation belongs to ATNS
- Pink – Primary responsibility for implementation belongs to ACSA
- Green – Primary responsibility for implementation belongs to ATNS and ACSA

The durations are noted to the left of each colored bar.

The individual start times for each group/enhancement is based on the study team's understanding of the individual enhancements and their dependencies towards achieving the capacity enhancing initiatives. For example, for the Runway/Taxiway Utilisation efficiency group, it is proposed that the Minimum Required Separation implementation not be started until approximately four months after the start of implementation for Addition of RETs, Near-Term Implementation of Master Plan, and Performance-Based Navigation for Arrivals, and approximately seven months after the start of implementation for Balancing Arrival/Departure efficiency group.

It is acknowledged that the duration of each task may require adjustment to some extent to align with current procedures and stakeholder communication requirements. Nonetheless, this

roadmap provides a general framework for the implementation of the recommended high priority initiatives, with focus on collaboration between ACSA, ATNS and each of the other critical stakeholders.
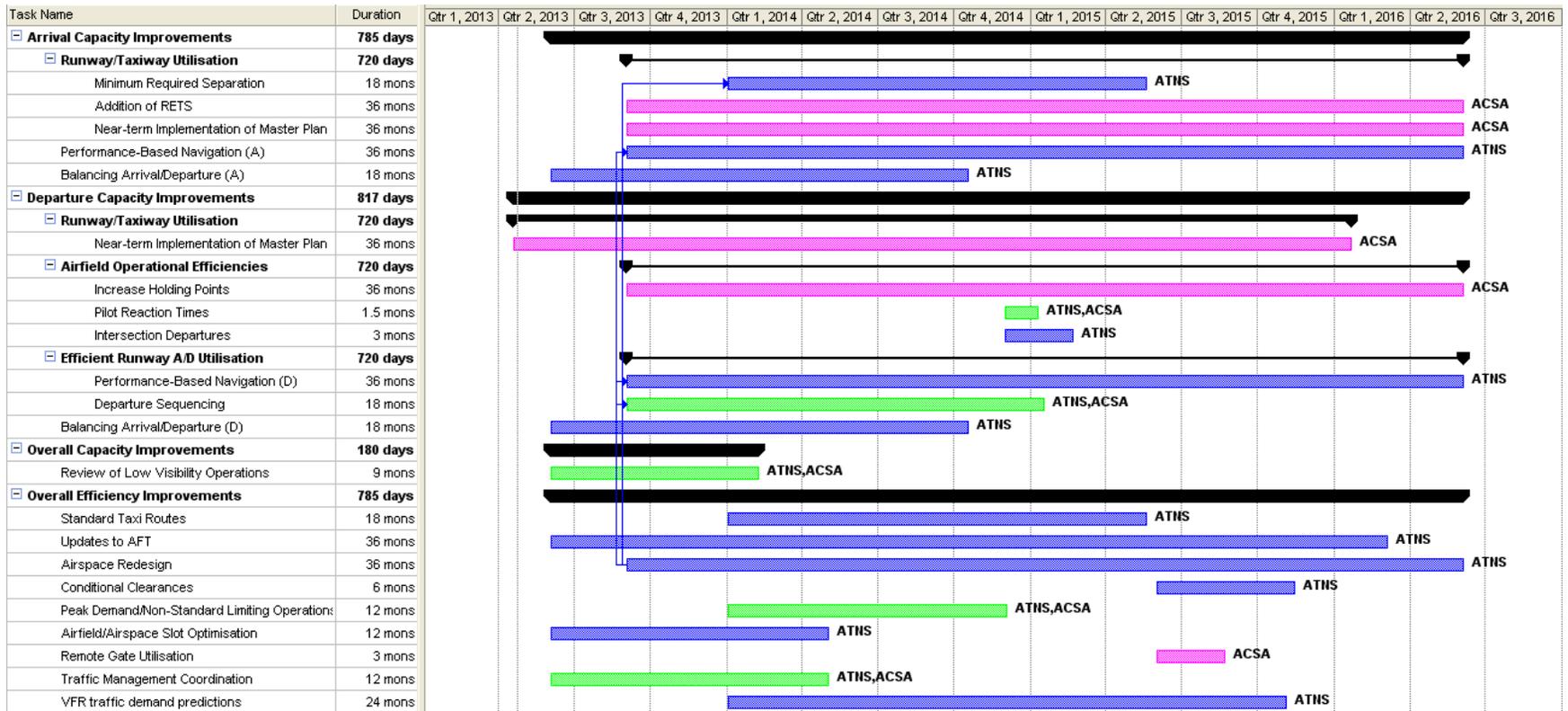
Figure 4: Proposed Joint Airside Capacity Enhancements Roadmap

3 Summary and Next Steps

This report culminates the assessment of airside capacity enhancements for FAOR, FALE, and FACT and proposes a framework for implementing a set of recommended enhancements. The implementation framework considers the role of triggers in determining when airport and airspace capacity enhancements need to be made. A preliminary analysis estimated increased traffic at varying demand growth rates and applied the new demand to the declared capacity rates. The preliminary results illustrated the trade-offs between growth and average delay per flight.

- An estimated 50-to-60% traffic increase by 2020 at current capacity rates increases flight delay to 10 to 11 minutes.
- A 5% increase in traffic in the near-term may add an additional minute of delay per flight.
- In the mid-term, flights may experience four to seven minutes of additional delay without capacity enhancements at the airports.

This is not a comprehensive analysis, but it does show an estimation of the impacts of the demand growth to help focus some attention on the trigger years in which we can apply some capacity enhancement indicatives to reduce the impacts of traffic growth.

The implementation process for enhancements should be initiated when the activity growth curve intersects the advance time required for the particular enhancement (Typically 12-18 months in advance of need). Standard implementation tasks were provided as guidance but should be replaced with the appropriate ATNS and ACSA rules of implementation.

1. Planning
2. Environmental Approval
3. Plan of Finance
4. Design
5. Permits
6. System Procurement
7. Procedure Development
8. Policy and Regulation Changes
9. Construction
10. System Installation
11. System Testing
12. Training
13. Charting
14. Communication

Finally, a proposed joint roadmap provides a framework for implementation. The implementation takes into consideration the goals and priorities of ATNS and ACSA, their stakeholders, implementation risks and dependencies, and benefits of implementation of the recommended airside capacity enhancements. The study team understands that this is the first

step in the process. This report and the initial joint roadmap should generate discussions among ATNS, ACSA, and their stakeholders, and lead to refinement of the roadmap.

 Based on the study team's past experience on studies for other Air Navigation Service Providers (ANSP) and airport operators, it is very rare for ANSPs and airport operators to have a well-coordinated, common road map for capacity enhancement. It is encouraging to note that from the outset of this study, ATNS and ACSA are working together to produce a joint roadmap for capacity enhancements. It is this collaboration that will prove to be most useful in the successful implementation of the recommended capacity enhancements.

The study team will consult with ATNS and ACSA to refine this implementation plan and will provide a subsequent update to this report. This report will be followed up by the SA ACES Final Report, Task 9, which is a summary of the previous eight reports, and then a final meeting to brief the results of this study will take place in Johannesburg with ATNS, ACSA, and stakeholders.