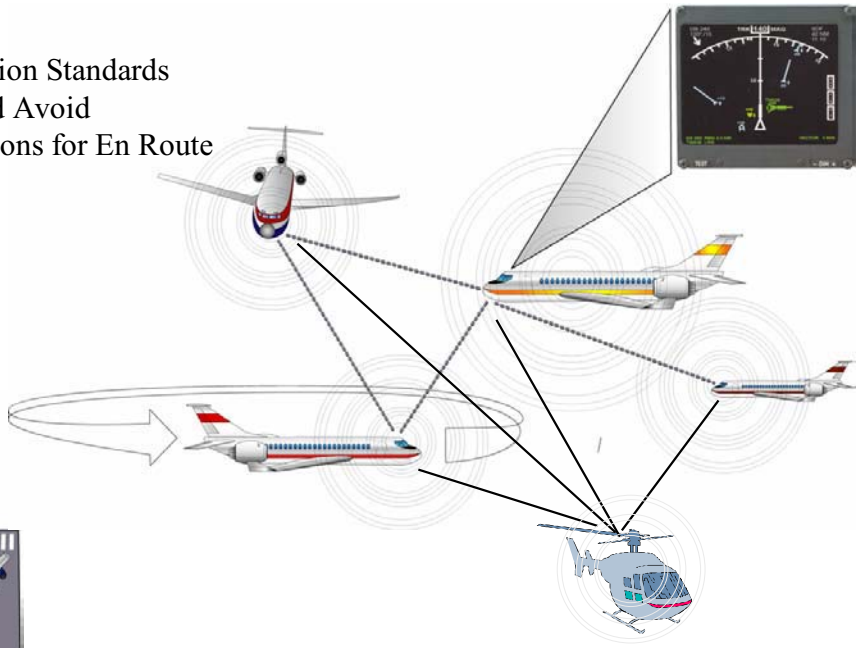
Rockwell Collins
ADS-B Perspective
Bangkok – March 2005

Arnold Oldach
aoldach@rockwellcollins.com

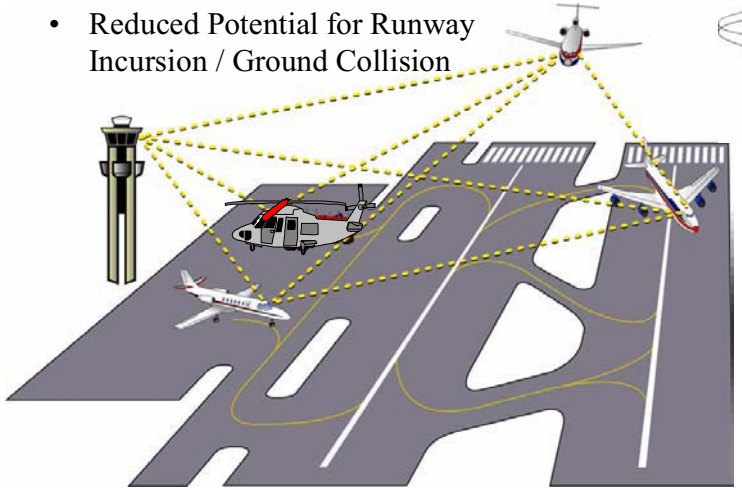
Rockwell Collins

ADS-B / CDTI is Expected to Enable a Wide Range of Operational Capabilities

Air-to-Air
- Improved Separation Standards
- Enhanced See and Avoid
- Enhanced Operations for En Route Air-to-Air



Airport Surface
- Improved Pilot Situational Awareness
- Enhanced Controller Management of Surface Traffic
- Reduced Potential for Runway Incursion / Ground Collision



Air-to-Ground
- Surveillance Coverage in Non-Radar Airspace (with Improved Separation Standards)
- Enhanced Special VFR Operations

Artwork credit: FAA Safe Flight 21 Office

Problems and Solutions

- **PROBLEMS**
  - Terminal area congestion
  - Runway incursions
  - Lack of traffic situational awareness (all phases of flight)
    Includes lack of airport surface situational awareness
  - Capacity-constrained air routes
  - Oceanic operation inefficiencies

- **SOLUTIONS**
  - Approach spacing, enhanced visual approaches, closely-spaced parallel approaches, CEFR (CDTI Electronic Flight Rules)
  - Surface / traffic situational awareness, runway incursion alerting
    Includes surface map with own ship (and traffic)
  - CDTI (long range)
  - Basis for Free Flight; Airborne Conflict Management (ACM)

ADS-B Transitions

- First Opportunity for ADS-B Implementation
- Platform Architecture for Functional Implementation
  - XPDR (1090ES)
  - Traffic Computer (TCAS / EFB Class 3, etc)
  - Displays (HMI, CDTI Development)
- Air to Air ADS-B Functionality Implemented
- First Significant aircraft architectural changes
- Certification Challenges Increase

Transmit Data
2003

- 1090MHz Squitter (Certified 2003)
- Basis for all future ADS-B Functions
- Must get Critical Mass of Equipage!

Receive and Display Data (Advisory)
2005+

- Implemented using current aircraft architectures
- Initial use of 1090ES
  - Other Physical Layers to Follow?
- Situational Awareness (visual acquisition)
- Surface and approach situational awareness

Process Data (Separation Assurance)
2012-15

- The Challenges Increase
- Higher Level of Criticality
- Airspace Procedural / Operational changes

Increasing Complexity

Architectural Categorization

Capability	Parked/ Soon to Retire	In Service / Out-of Production	In Production	Block Upgrade /New Design
Tier 0 (ELS, EHS)	-	++	++	++
Tier 1 (Ext. Squitter)	-	++	++	++
Tier 2 (Package 1) (Situational Awareness)	-	+ (++?)	++	++
Tier 3 (Package 1+) (TCPs/Guidance Cues)	-	Block Upgrade	Block Upgrade	Provision
Tier 4 (ASAS)	-	Block Upgrade	Block Upgrade	Provision

-	No perceived cost justification (there may be spot market opportunities, including military)
+	There is justification (Benefits / Regulatory) on fleet- , operator-, or regional-specific basis
++	There is justification or OEM plans (Benefits / Regulatory)
Block Upgrade	Block upgrade needed to support minimum Tier 4 / perhaps Tier 3 app's
Provision	Baseline system should contain provisions for Tier 3 and 4 app's

Affected Aircraft Systems – Look Ahead

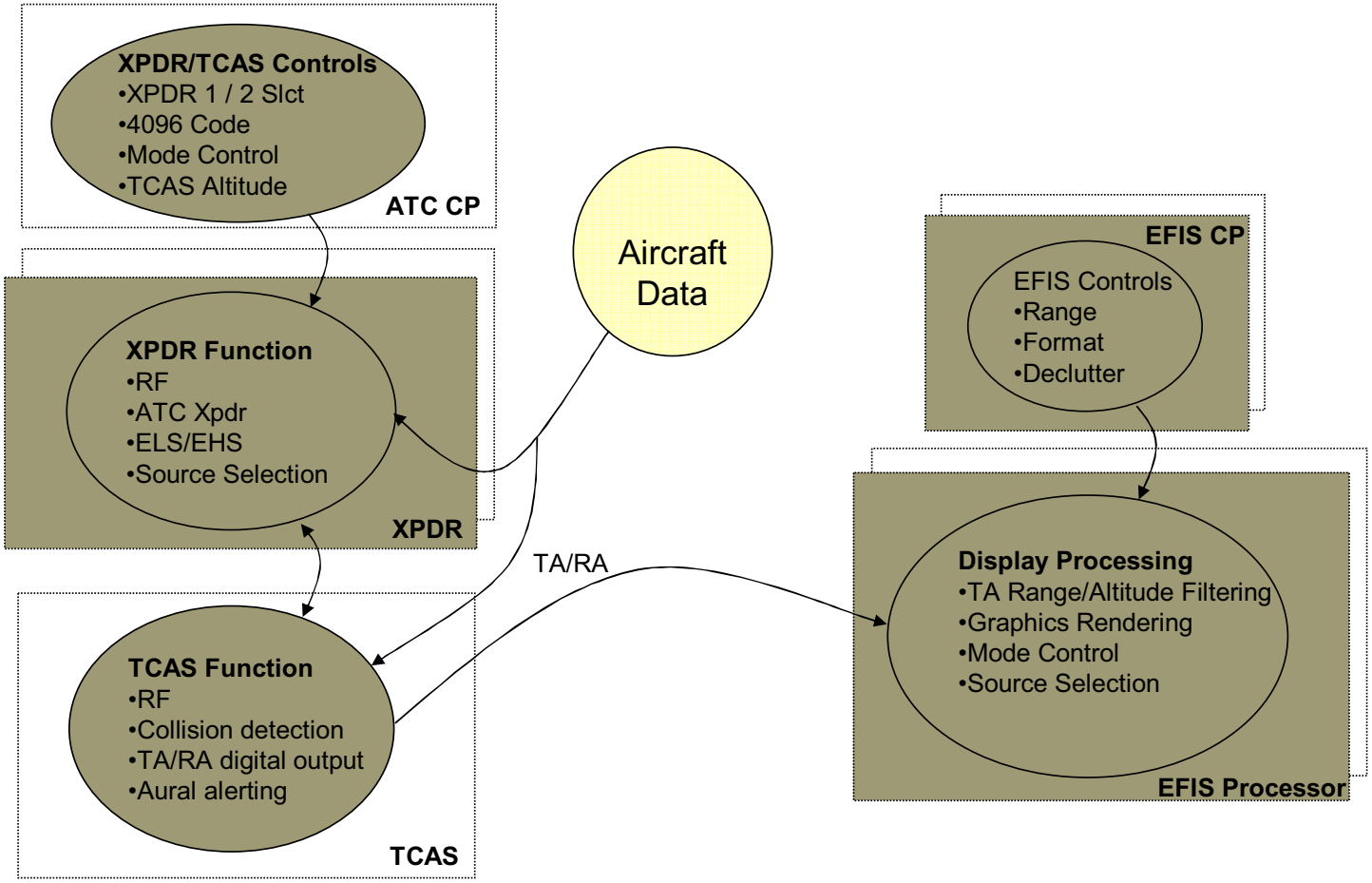
System	Tier 0 (ELS/EHS)	Tier 1 (Ext. Squitter)	Tier 2 (Sit. Awareness)	Tier 3 (TCPs / Guidance)	Tier 4 (ASAS)
Surveillance	XPDR Upgrade A/C Wiring	XPDR Upgrade A/C Wiring [1]	ADS-B Rcve Fcn. Surv Proc Function. UAT/VDL Mode 4, Multi-link option.	Increased availability and continuity (dual system). ASA App's	Increased availability and continuity (dual system). CD&R App's Squitter FPI
Navigation		GNSS PVT Source (w/RNP RNAV perf) (e.g., GNSS MMR)	Improved PVT and continuity for precision appr/dep and surface ops	Increased integrity, availability, and Continuity FMS Intent (TCPs).	Increased total system perf. FMS Intent. Route Negotiation
Communication			ACARS Data Link ARINC 623 FANS (Oceanic) ATN CPDLC - Europe	ATC Data Link: - Clearances - Weather / hazard - Frequencies - Flight plan - Charts / NOTAMS	Seamless Data Link
Display			CDTI Surface Map Spacing Cues HUD Option	CDTI Surface Map Guidance Alerting HUD Option	CDTI Surface Map Guidance Alerting HUD Option

[1] OEMs are implementing 1090 ES aircraft wiring provisions in ELS/EHS upgrade.

All Aircraft Types and Categories are Affected (ATS, Bus/Regional, Military)

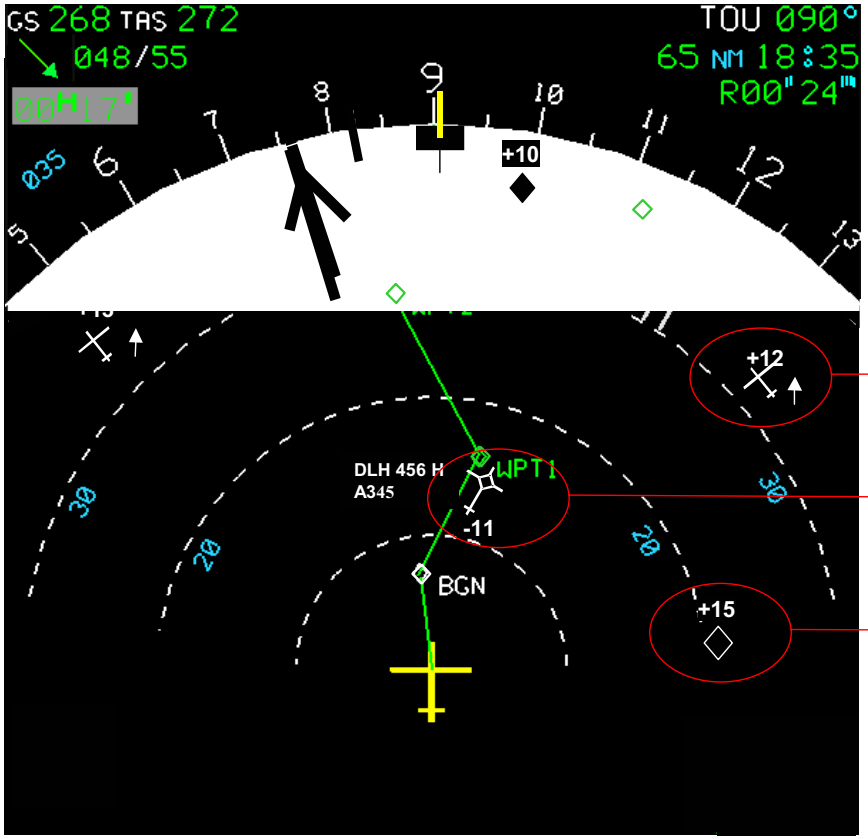
Need to consider all aircraft systems

Functional Diagram - Current Surveillance Systems



Airbus CDTI Examples

Notional Concepts of See and Avoid on a current generation display.



Flight Deck Consistency

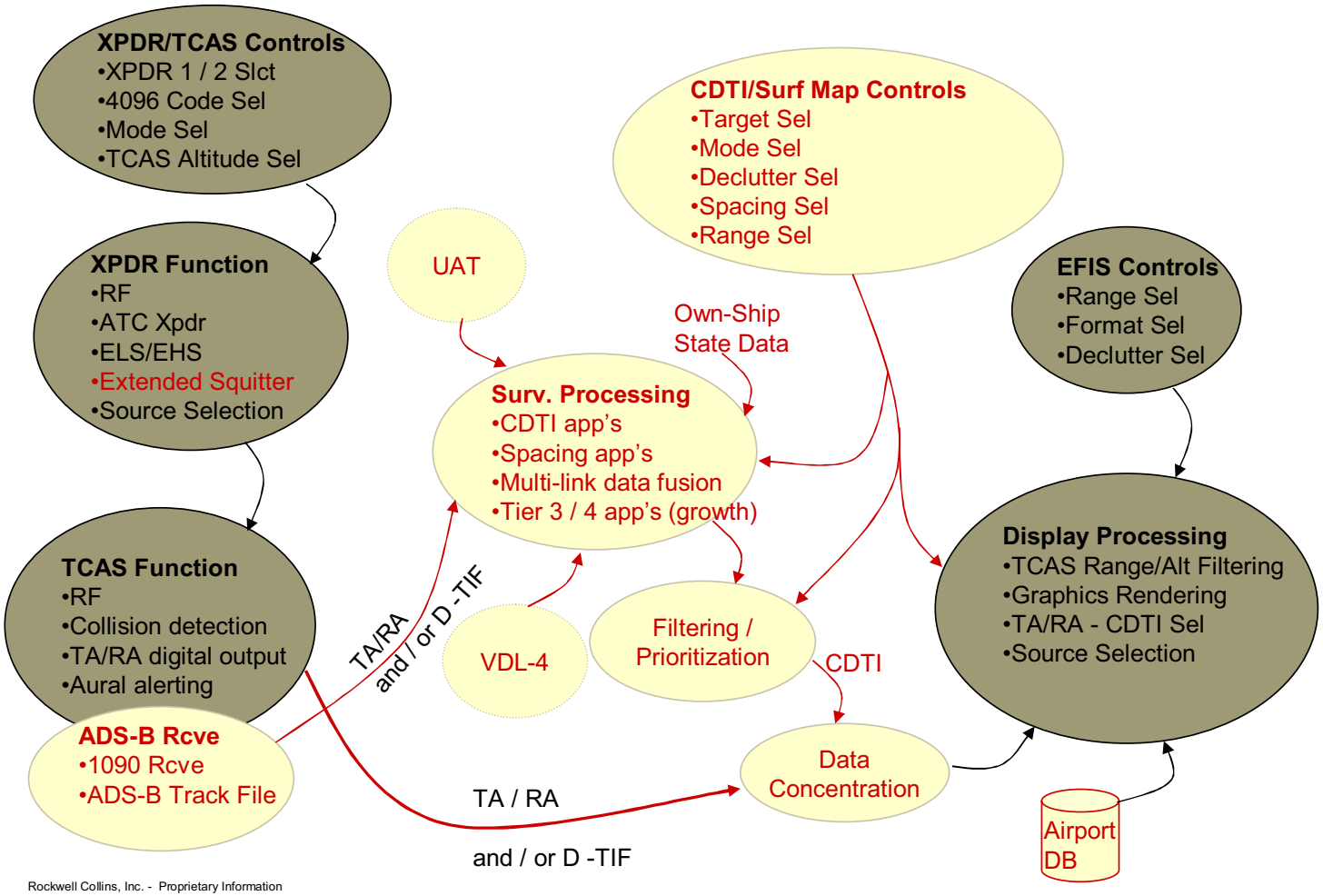
- Normal situation presented
- Integration of TCAS alerts
- Integration of TIS-B data

ADS-B aircraft

Aircraft seen by TCAS and ADS-B

TCAS, non ADS-B aircraft

Functional Diagram - Future Surveillance Functions



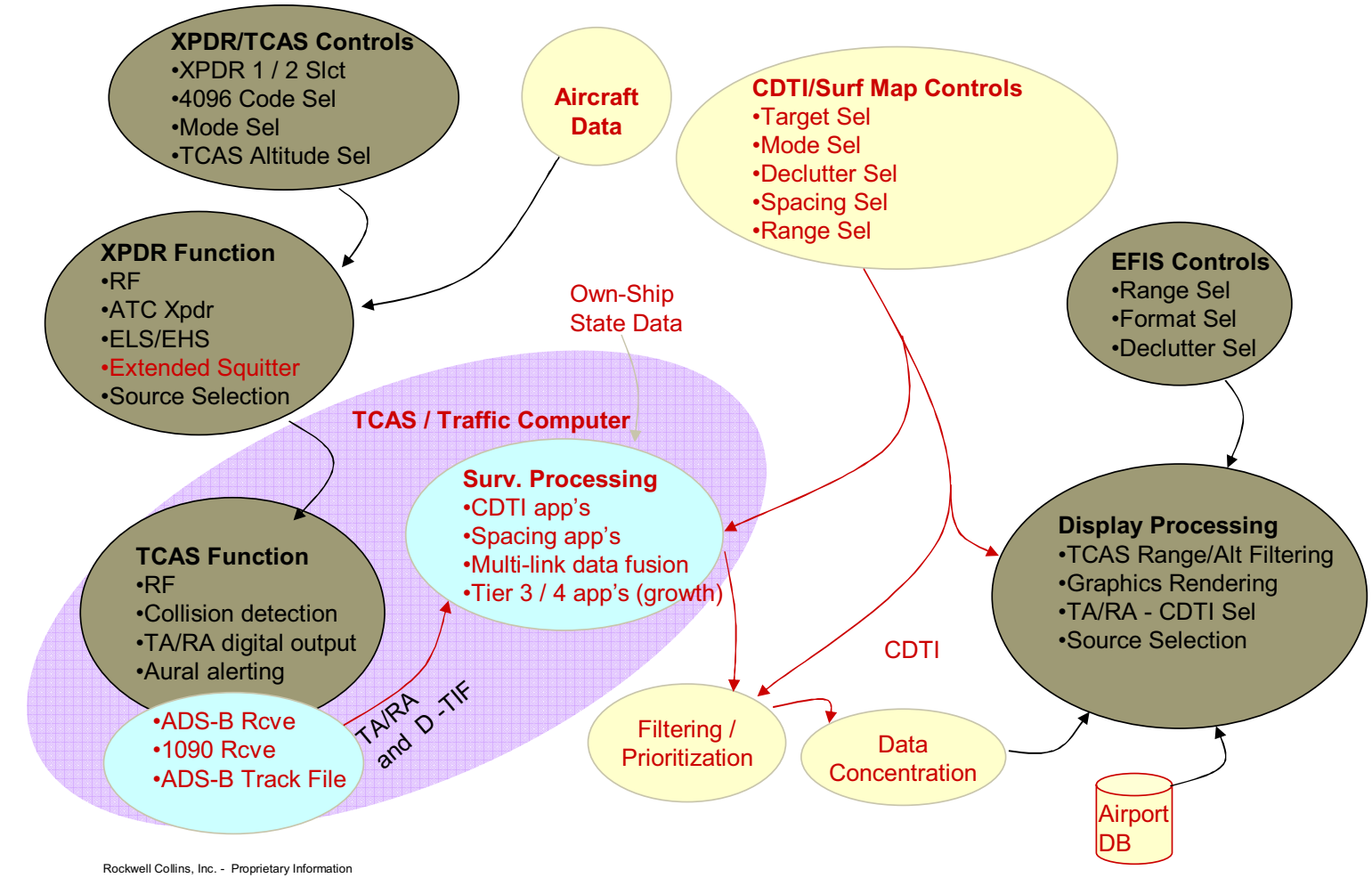
Current Thinking on Architectural Options

Architectural Options

- **TCAS – Traffic Computer Based Architecture (ARINC 735A)**
  - Receive and Process 1090 MHz Extended Squitter
    - **Output Display Traffic Information File (D-TIF)**
      - **As Defined in ARINC 735A**
    - **To Flight Deck Display**
      - **Either to Navigation Display (ND), or to alternate architecture (EFB)**
- **EFB Class III with Traffic Computer Based Architecture**
  - Receives D-TIF from TCAS or other source (e.g. 1090MHz, UAT or VDL Mode 4)
  - Performs Traffic Computer Functions
    - **Processes data/merges data/outputs graphics)**
  - Cockpit Display of Traffic Information
    - **CDTI for targets and target data**
- **Next Generation Aircraft (A380 / B787) Integrated Surveillance Systems (ARINC 768)**
  - ADS-B Transmit will be Standard for Entry Into Service (EIS)
    - **Timing of Entry Into Service – Architecturally prepared**
      - 1090 MHz Extended Squitter
      - DO260 or DO260A depending upon entry into service
  - Cockpit Display of Traffic Information
    - **Architecturally prepared to meet mandates / requirements**
      - CDTI Growth for additional targets and target data
  - Aircraft Separation Assurance (Assistance) System – Architecturally prepared

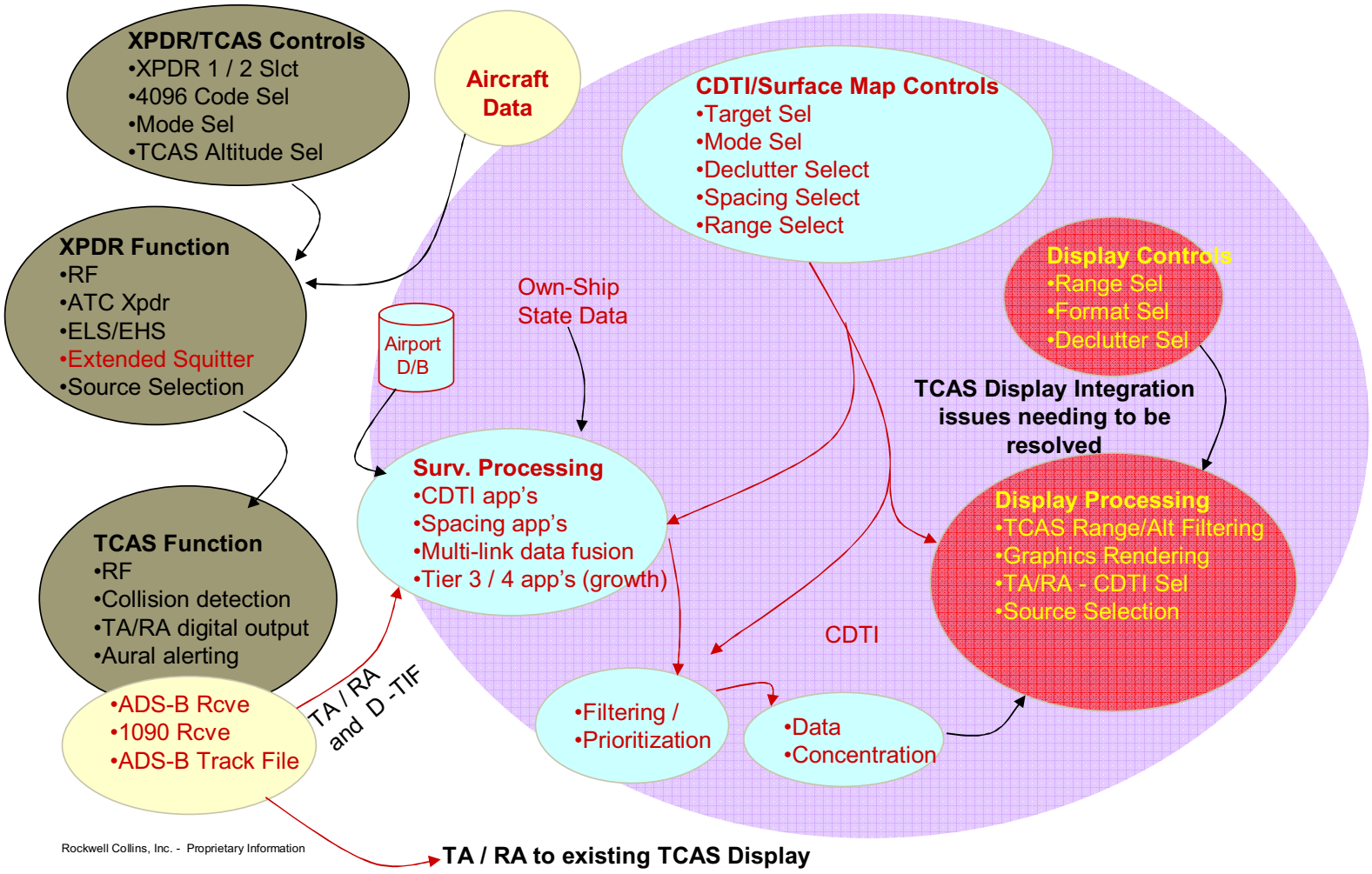
Functional Diagram – TCAS / Traffic Computer

(Forward Fit or Retrofit Solution –Using Aircraft Primary Flight Displays)



Functional Diagram – EFB / Traffic Computer

(Retrofit Solution – Not Using Aircraft Primary Flight Displays)



Objective/ drivers for NUP 2+

Summary of Presentation
from
Swedish Luftfartsverket

To continue the development of ADS- B based applications providing benefits for commercial airline traffic, ANSP's and airports.

To be more focussed in the development and validation work

To create sustainable solutions

To support European ATM vision

Status Report

NUP II Steering Committee Meeting

Innsbruck - 10 August 2004

LUFTFARTSVERKET

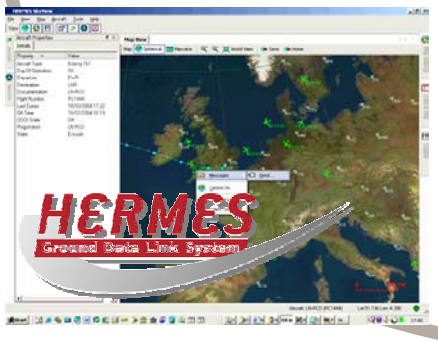
NUP II+ Essence

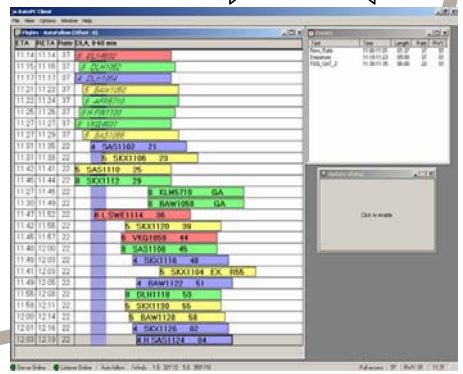
Summary of Presentation
from
Swedish Luftfartsverket

COCKPIT

AIRPORT

Smiths 10.6





AOC

ATC

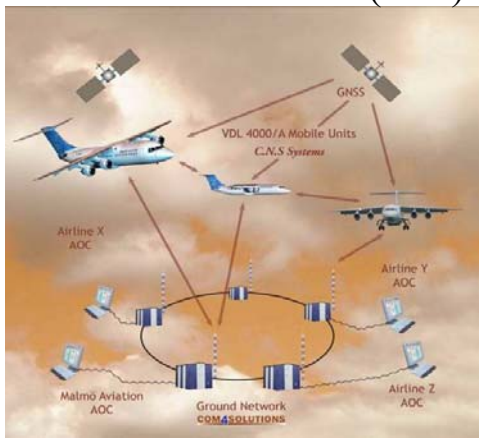
LUFTFARTSVERKET

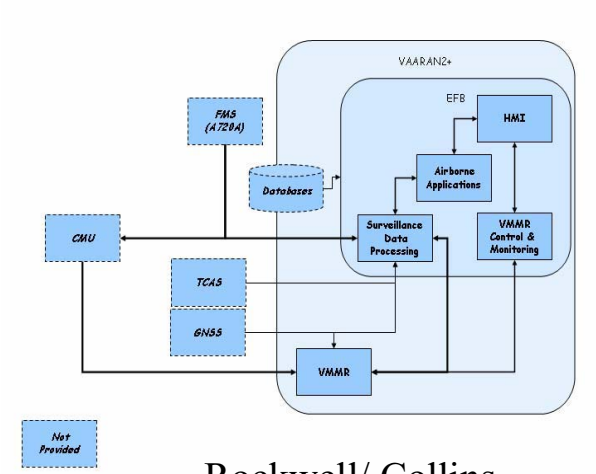
Industry group

Summary of Presentation
from
Swedish Luftfartsverket

Committed industrial support from day 1 to ensure availability of Systems for validation.

Information networks(C4S)

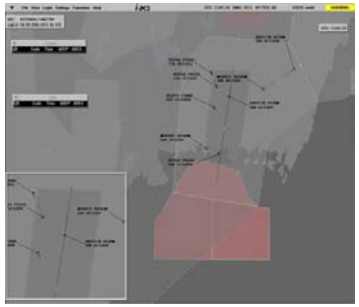




Rockwell/ Collins

Smiths

Avtech



ATC(Sweden/ Austria)

LUFTFARTSVERKET

Rockwell Collins NUP2+ Architectural Overview

B737 FMS
Smiths

Output 4D trajectory

ACARS bus
+ 4D trajectory

CMU Collins

AOC & CDM app
(4D trajectory
from FMS to VHF)

Collins
Class 3 EFB

Traffic
computer

HMI

Applications

- ADS-B out
- ATSA-SURF

Collins VHF-2100

VHF Comm | ACARS | VDL-2 | VDL Mode-4

Broadcast & Receive ADS-B

VDL Mode 4 for the NUP Trials. However, interface will support 1090 MHz Extended Squitter

Integrated Surveillance System

Weather Radar

8 MCU

TCAS

6 MCU

ISS-2100

- Weather Radar
- TCAS
- Mode S
- TAWS
- ADS-B (Capable)

Mode S

4 MCU

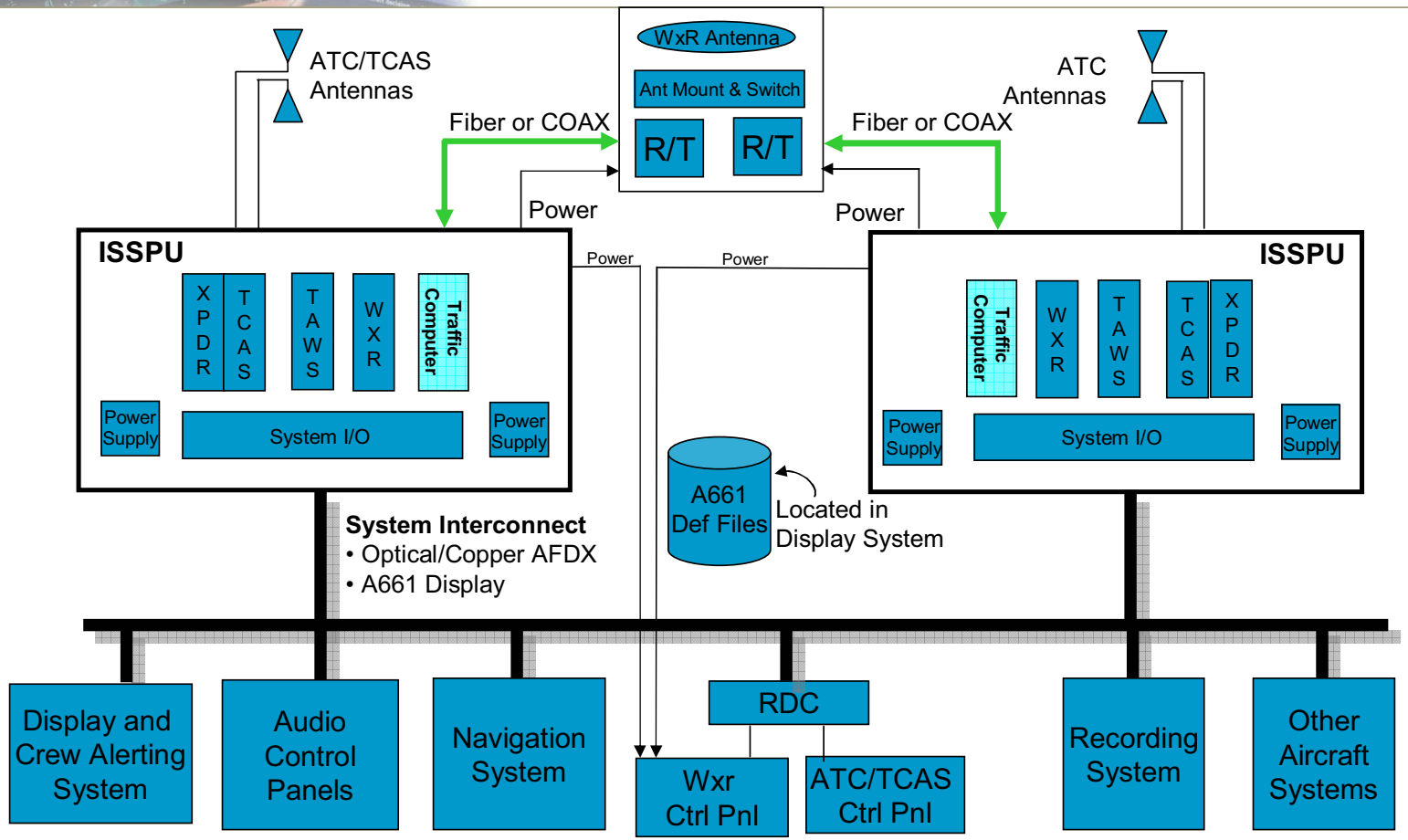
TAWS

2 MCU

8 MCU

ISS-2100

System Architecture
(Arinc 768 Generic Dual Installation Overview)



The Integrated Surveillance Systems are expected to be the future enhanced surveillance platforms!

Summary

- **TCAS Traffic Computer – Targeted for in production federated architecture aircraft**
  - Primary candidates for TCAS based Traffic Compute Architectures
  - These will be provided by the aircraft manufacturer
  - Integrated into the aircraft systems (TCAS, Controls, and Display Systems)
    - **Will be consistent with aircraft manufacturer HMI concepts and philosophies**
      - Flight Deck consistency
- **EFB Class 3 Traffic Computer – Targeted for Retrofit**
  - Uses EFB Class 3 Avionics Platform (File Server) with an EFB Display
    - **Eliminates the need to upgrade existing aircraft display systems**
    - **1090MHz receive and Traffic Information File creation / output issue needs resolution**
      - **Is it TCAS, or a separate 1090MHz receiver**
    - **How far can the architecture be taken**
      - **Which CDTI applications will the architecture support**
- **Integrated Surveillance System**
  - The next generation architecture for the next generation aircraft
    - **A380 and B787 are first**