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# *Provisioning of Air Traffic Data Link Services in WCDMA*

Jenny Jin

**ITT – Advanced Engineering & Sciences**



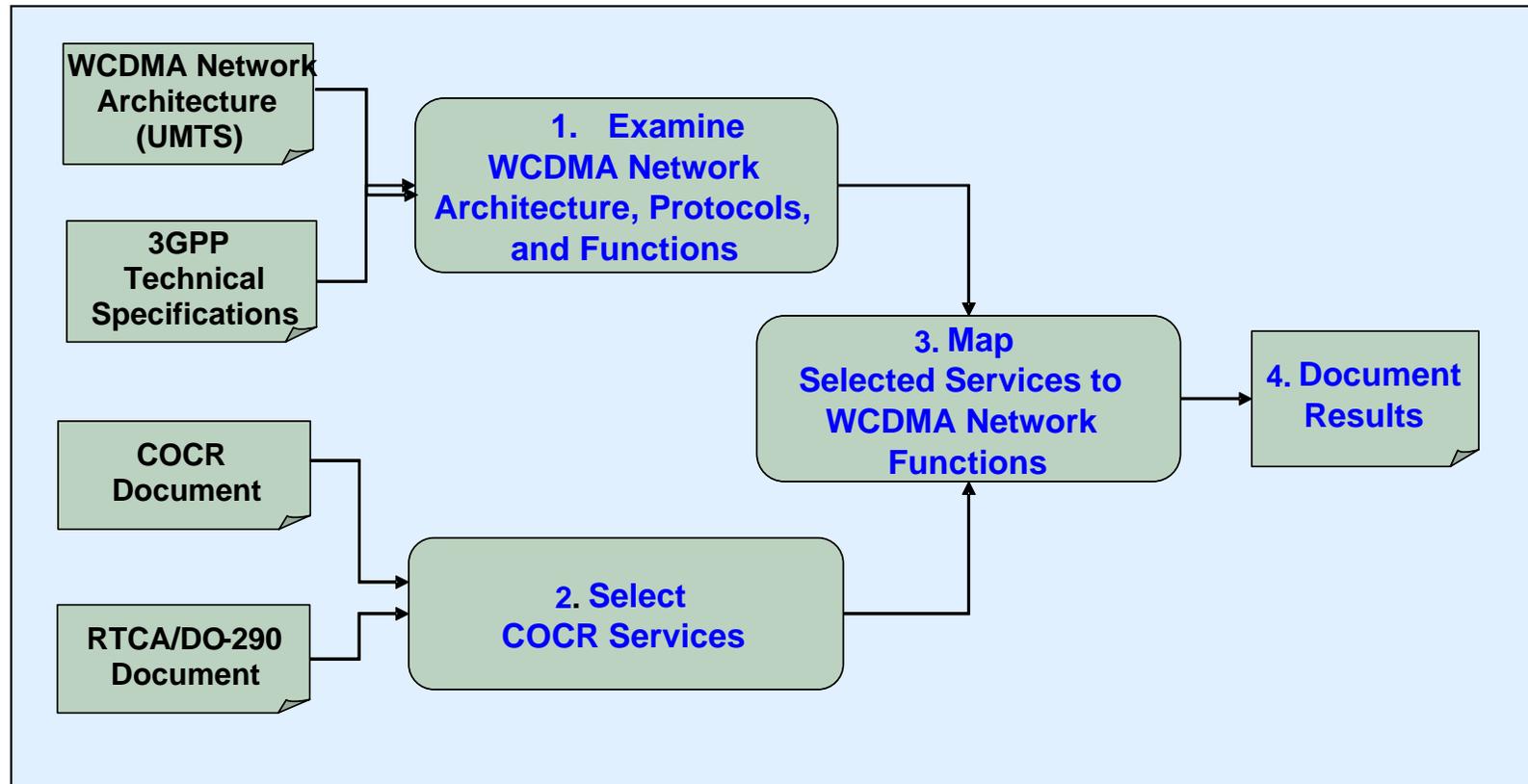
# *Outline*



- 
- Background
  - Approach
  - WCDMA Network Architecture
  - Selection of COCR Services for Analysis
  - Mapping Services into WCDMA Network Functions
  - Conclusions

- The Future Communications Study (FCS) is a joint study between the FAA and Eurocontrol
  - To identify communication technologies and needs of future flight communications in the 2015 to 2025 time frame
- FCS has two main activities
  - Deriving Communications Operating Concept and Requirements for the Future Radio System (FRS) (COCR document)
  - Identifying most appropriate candidate technologies to meet the requirements (technology evaluations)
- NASA is a significant contributor to the FCS with primary responsibility for technology evaluations
  - ITT is contracted to NASA to perform the FCS technology evaluations
  - Technology evaluations are a scheduled three year activity

- WCDMA was identified as a promising FRS technology candidate from the FCS Technology-Screening process
- WCDMA is a wideband spread-spectrum mobile telecommunication air interface that uses code division multiple access (CDMA)
  - One of the main technologies for third-generation (3G) cellular systems
  - WCDMA was selected as the air interface for UMTS (Universal Mobile Telecommunication System), the 3G successor to GSM (Global System for Mobile communication)
- Task objective is to identify how WCDMA can be used to provide COCR services
  - Determine necessary elements of the WCDMA network
  - Results help the assessment of cost, certification and standardization impact
  - This analysis complements previous detailed WCDMA performance investigations initiated by Eurocontrol
    - Determine spectrum required in L-Band to services based on COCR requirements
    - Compatibility of WCDMA with existing aeronautical systems in L-Band



- **Elements of the study approach include:**

- Provide logical mapping of WCDMA network components to CNS/ATM system elements
- Map selected air traffic data link services defined in COCR to WCDMA network functions
- Sequence diagrams show functional interactions

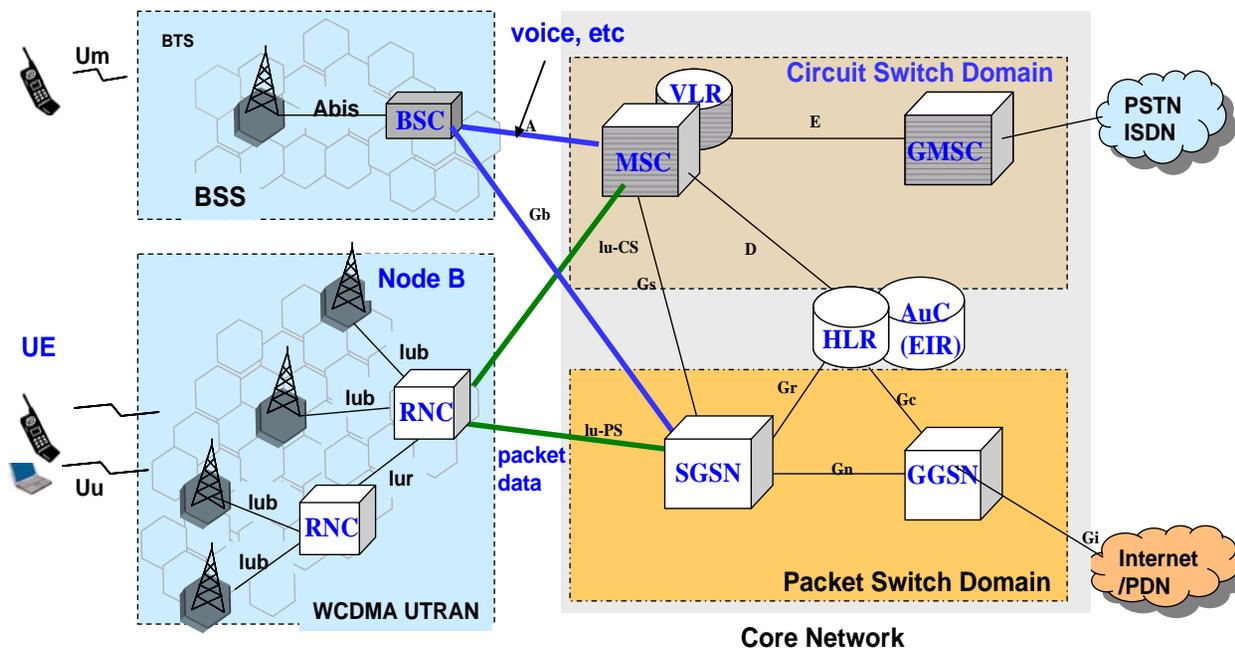
## UE – User Equipment

## UTRAN – UMTS Terrestrial Radio Access Network

- **Node B (Base Station)** -- Radio transmission / reception
- **RNC (Radio Network Controller)** -- Controls radio resources and Node Bs

## CN -- Core Network

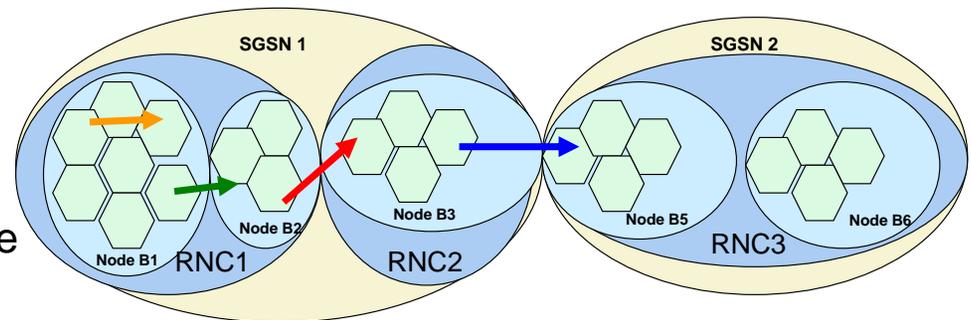
- **SGSN (Serving GPRS Support Node)** -- Handles packet switched (PS) data
- **GGSN (Gateway GPRS Support Node)** -- Handles packet switched (PS) data to the external network
- **HLR (Home Location Register)** -- Stores user's service profiles
- **VLR (Visitor Location Register)** -- Stores copy of visiting user's service profiles



**AuC:** Authentication Center  
**BSC:** Base Station Controller  
**EIR:** Equipment Identity Register  
**GGSN:** Gateway GPRS Support Node  
**GMSC:** Gateway Mobile Switching Center  
**HLR:** Home Location Register  
**MSC:** Mobile Switching Center  
**RNC:** Radio Network Controller  
**SGSN:** Serving GPRS Support Node  
**SLR:** SGSN Location Register  
**VLR:** Visitor Location Register  
**UE:** User Equipment  
**Uu:** Radio Link Interface  
**UTRAN:** UMTS terrestrial RAN

High Level UMTS/WCDMA Network Architecture

- **Access Network**
    - Finding access point
    - Localize user equipment
    - Establish connectivity for signaling
    - Registration + Authentication & Authorization
    - Establish connectivity for data transfer
      - PDP Context Activation
  - **Route/Transfer data**
    - Transfer data
    - Routing
  - **Detach from the Network**
    - PDP Context Deactivation
  - **Mobility Management**
    - Location Management
-  – Cell Update
  -  – Inter Node B/Intra RNC/Intra SGSN
  -  – Inter RNC/Intra-SGSN Routing Update
  -  – Inter-SGSN Routing Update

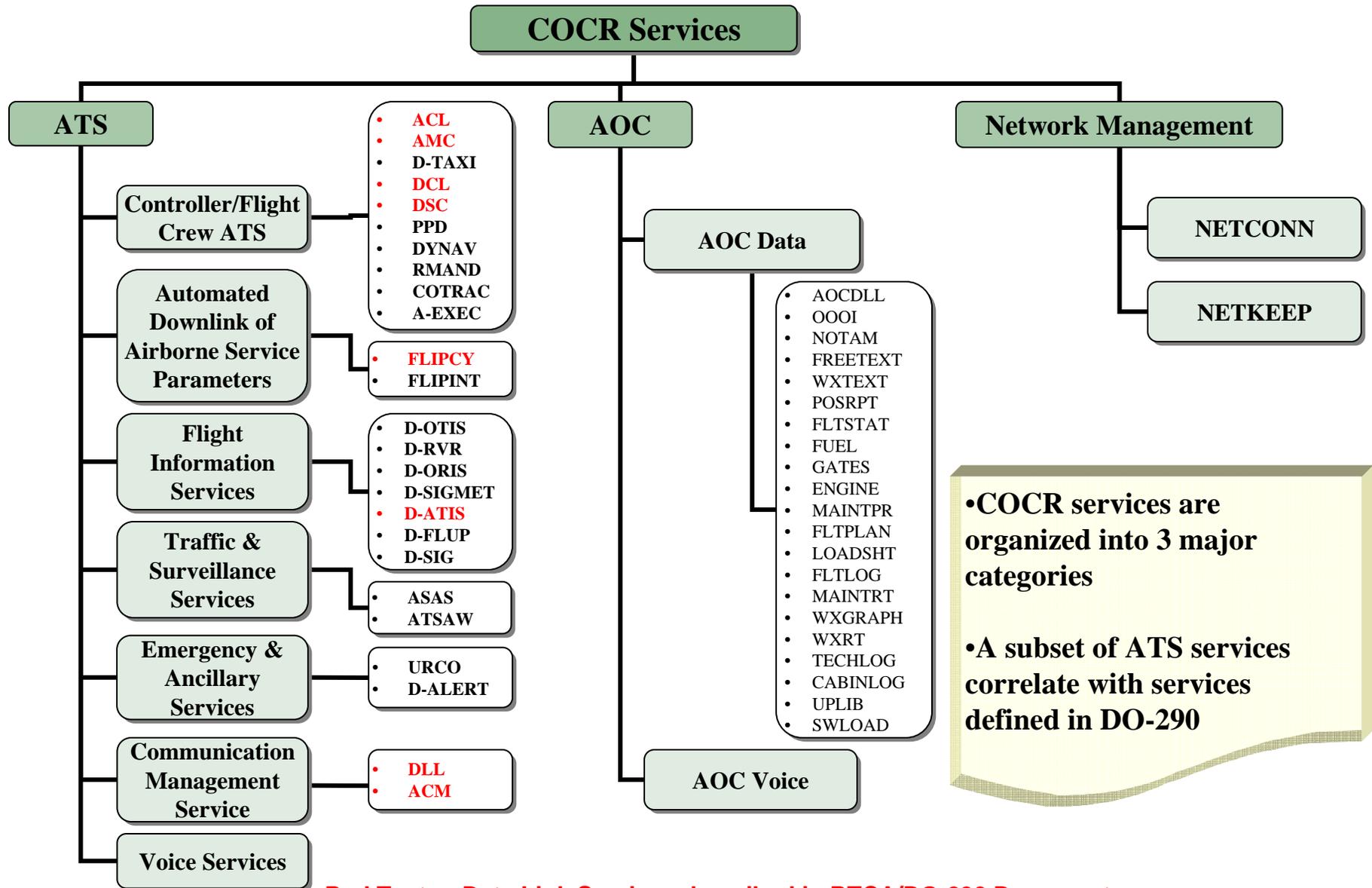




# *Selection of Air Traffic Data Link Services*



- **A set of air traffic data link services is selected**
  - To identify required WCDMA functional elements/protocols for provisioning aeronautical communications
  
- **Sources of service information**
  - **COCR is the primary source**
    - COCR includes a complete set of FRS data link service definitions
    - COCR includes service descriptions and operational context
  - **RTCA DO-290 is another source**
    - provides the minimum requirements for Air Traffic data link services in continental airspace
    - Services described in RTCA/DO-290 were the basis for some service definitions in the COCR
    - RTCA/DO-290 provides more transaction details than the COCR
      - » Operational methods, sequence diagrams, abnormal events, safety, performance



•COCR services are organized into 3 major categories

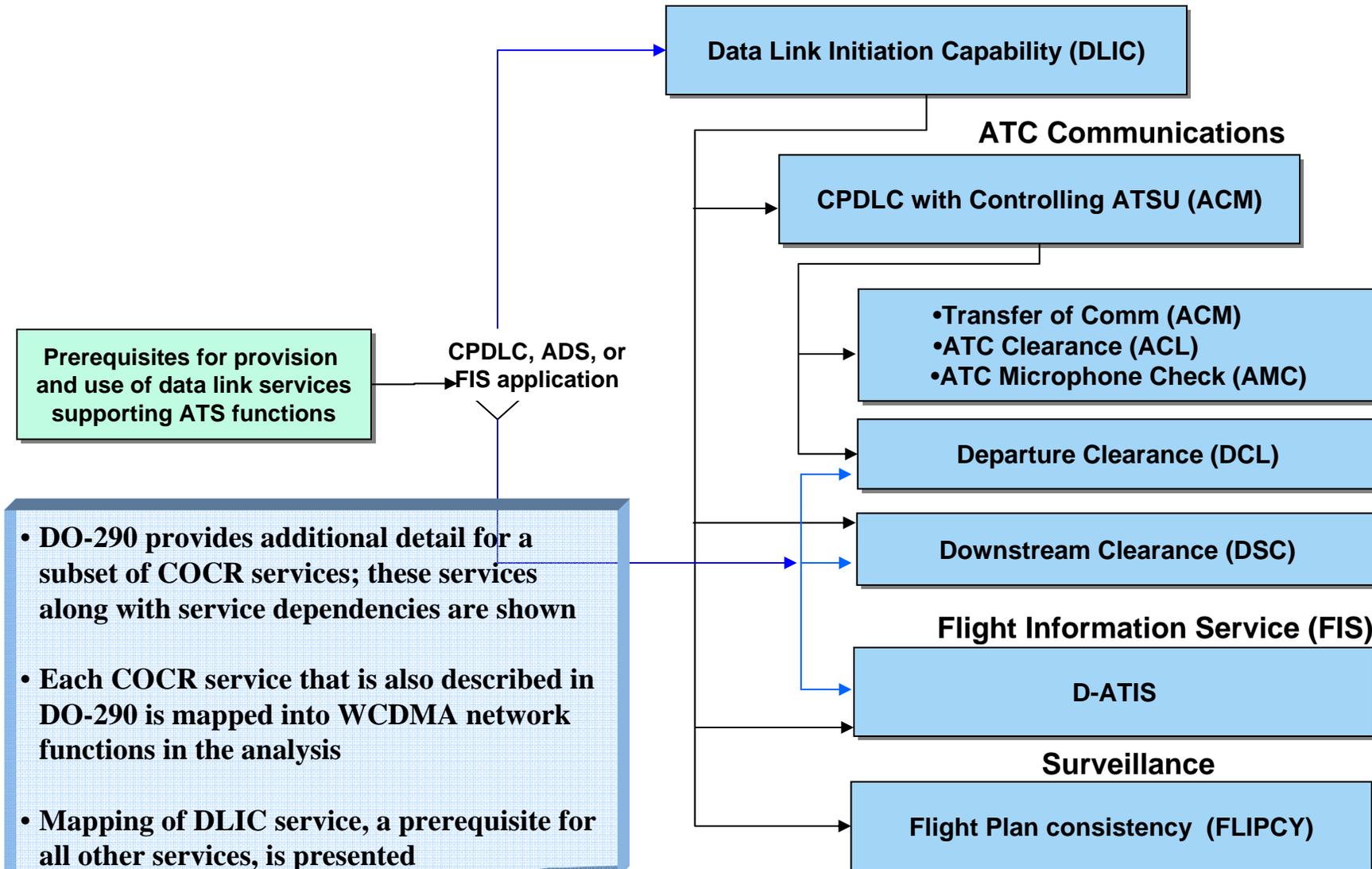
•A subset of ATS services correlate with services defined in DO-290

Red Text -- Data Link Services described in RTCA/DO-290 Document

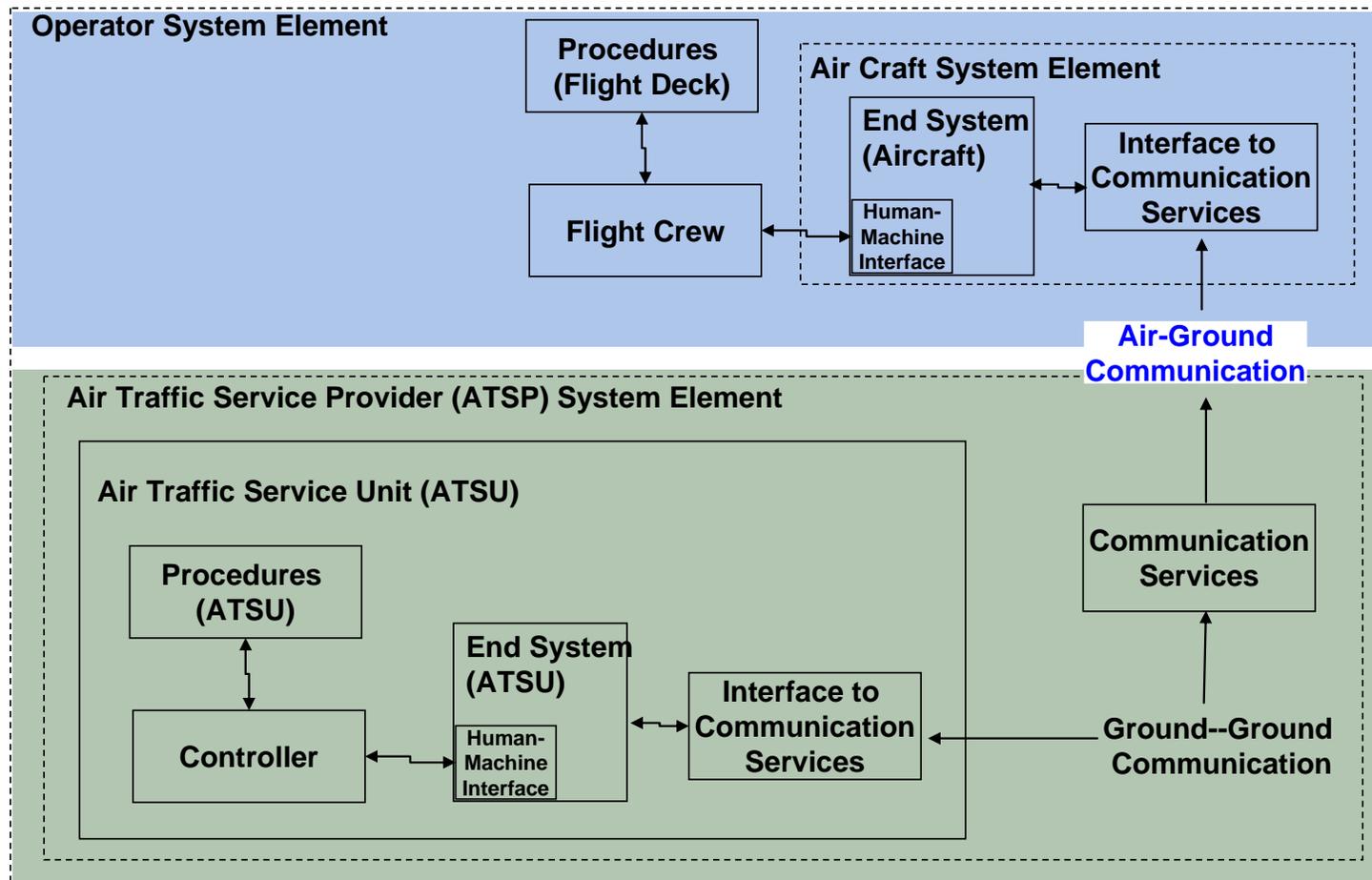


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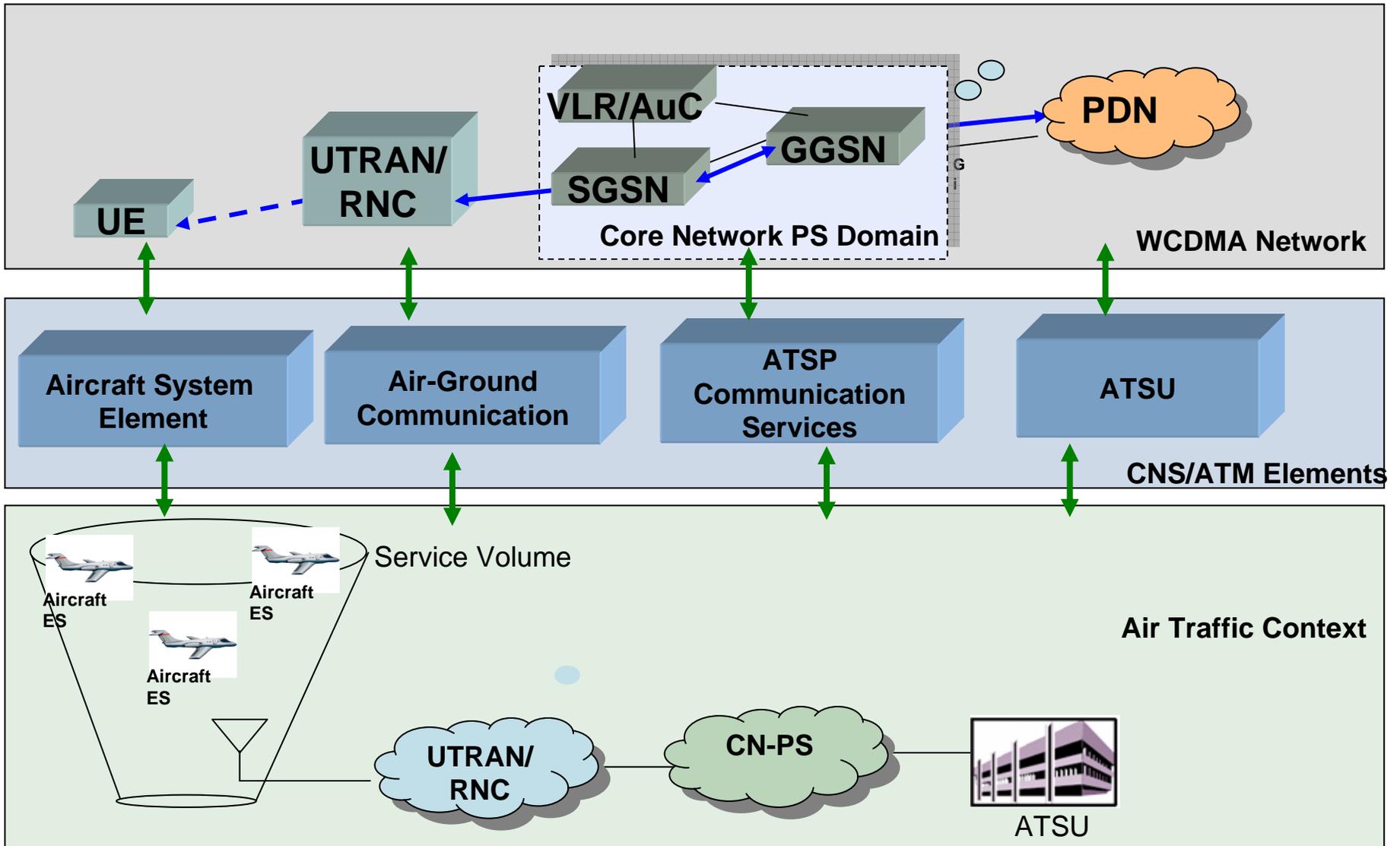
# RTCA/DO-290 Data Link Services & Dependency Diagram



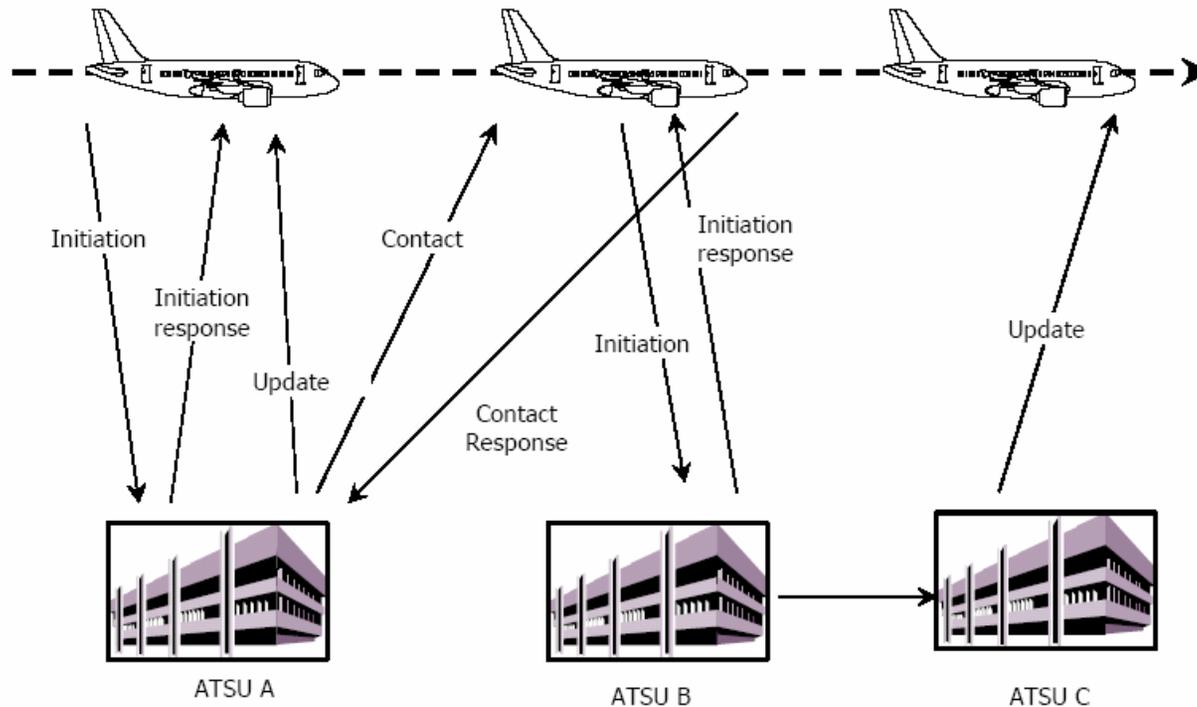
- DO-290 provides additional detail for a subset of COCR services; these services along with service dependencies are shown
- Each COCR service that is also described in DO-290 is mapped into WCDMA network functions in the analysis
- Mapping of DLIC service, a prerequisite for all other services, is presented



- To map COCR services to the WCDMA functional architecture, the CNS/ATM functional elements within the context of COCR services are identified
  - Major CNS/ATM elements include **Aircraft System Element**; **Communication Services** and **ATSU End System**



- DLIC (Data Link Initiation Capability) service is used to uniquely identify an aircraft
  - DLIC exchanges information between an aircraft and an ATSU
  - DLIC provides version and address information for all data link services
  - DLIC service is executed prior to any other data link services
- DLIC functions
  - INITIATION
  - CONTACT
  - UPDATE



## INITIATION

- Exchange information and provide flight data to an ATSU. Information for other ATSU (up to eight) maybe exchanged

## CONTACT

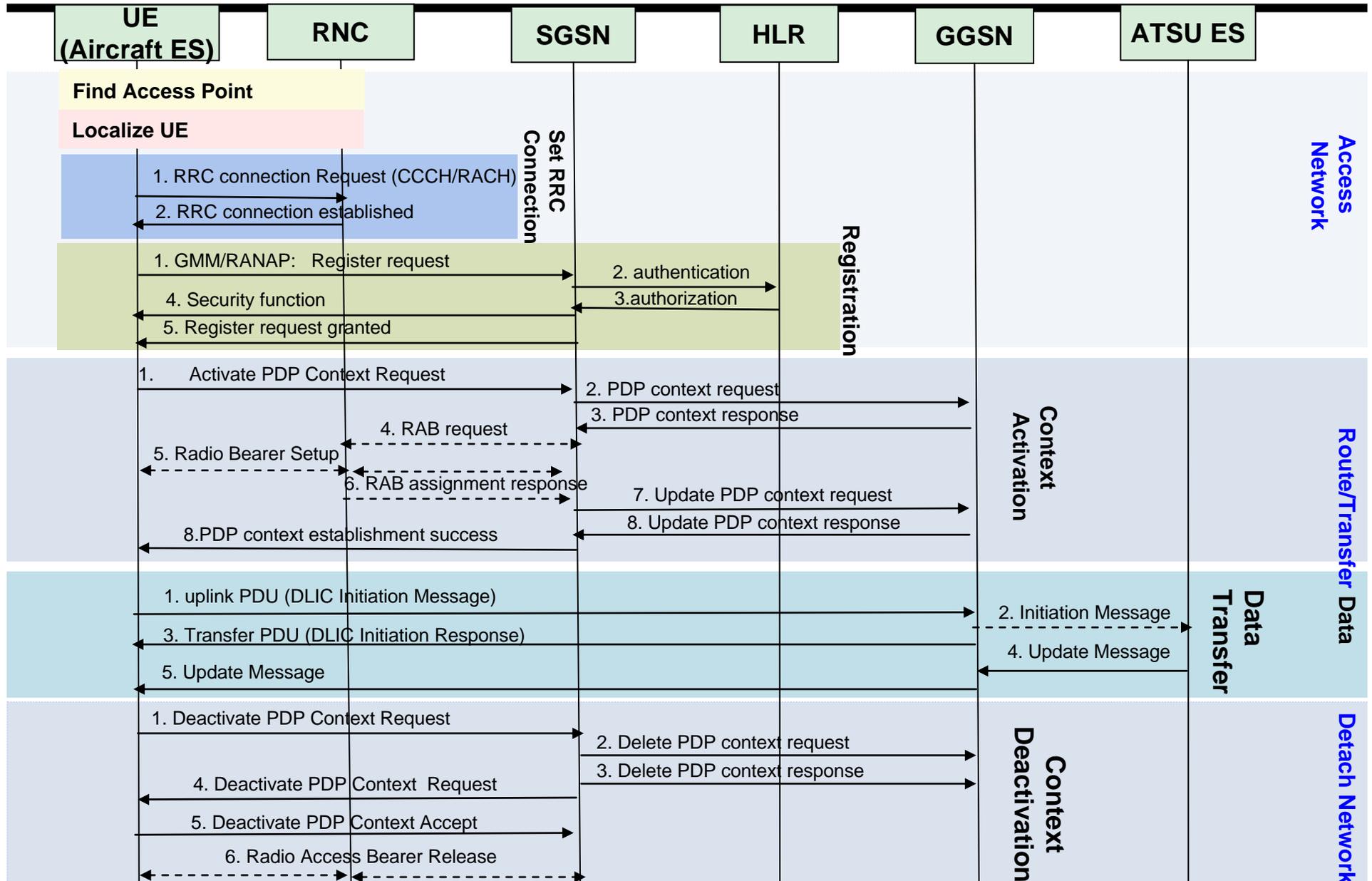
- An ATSU provides the DLIC address of a specific ATSU to an aircraft and requests the initiation function be performed between the aircraft and the specified ATSU

## UPDATE

- An ATSU provides its updated initiation information to an aircraft. The ATSU may update the information for other ATSUs when the ATSU has such initiation information



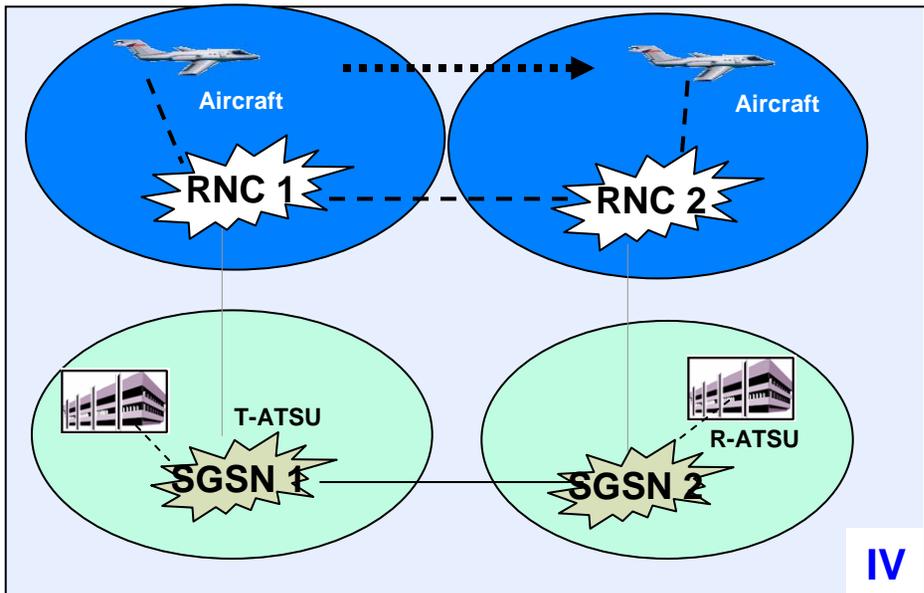
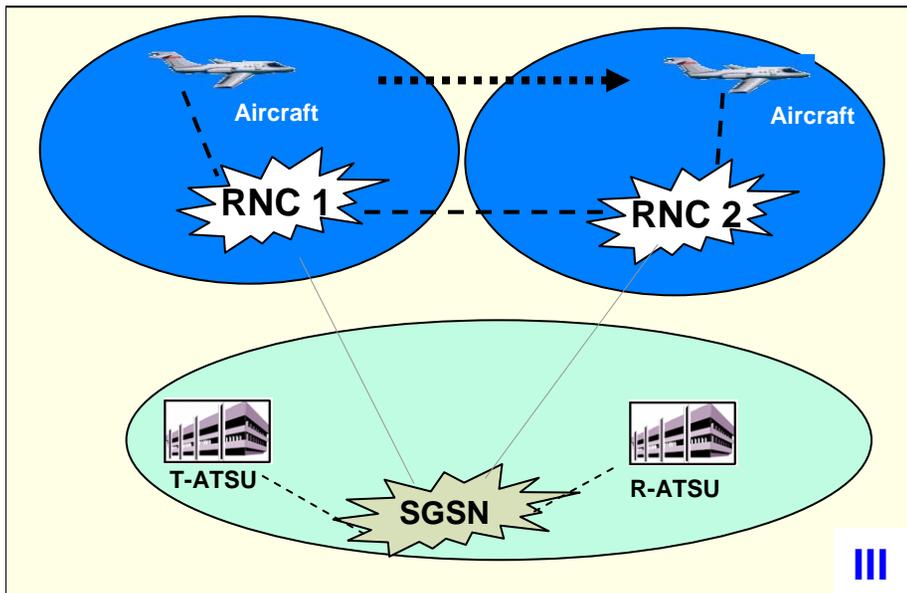
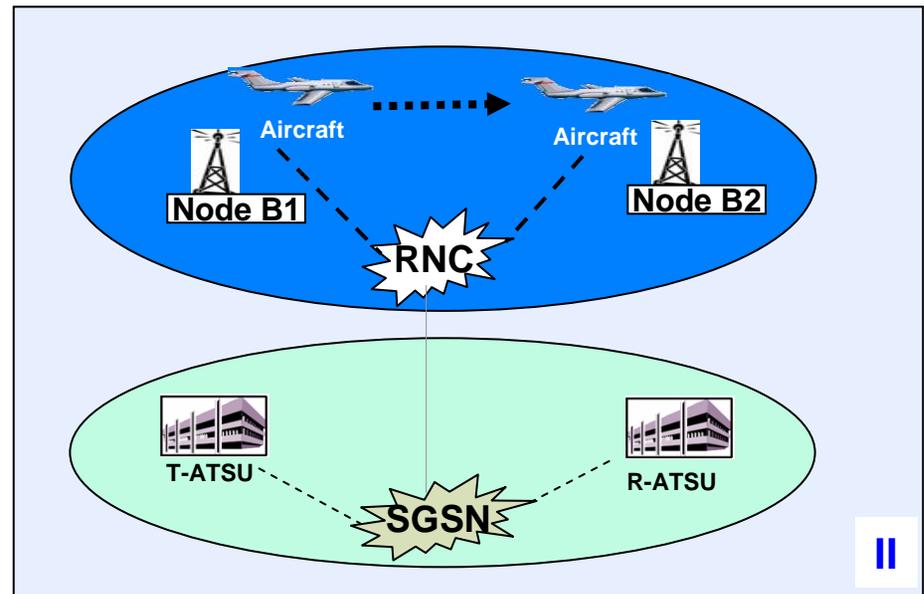
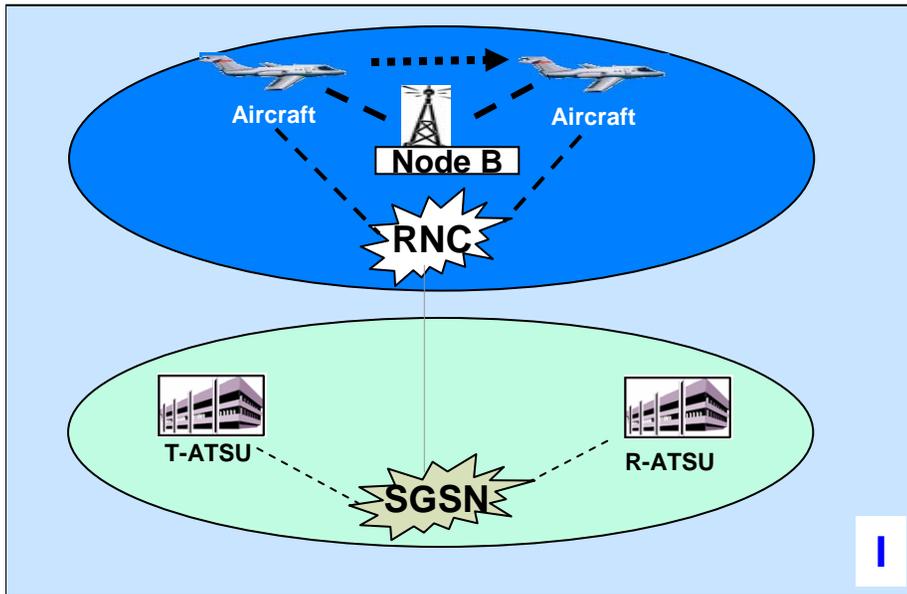
# Map DLIC to WCDMA Services – Initiation + Update Functions





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# Aircraft Movement Scenarios



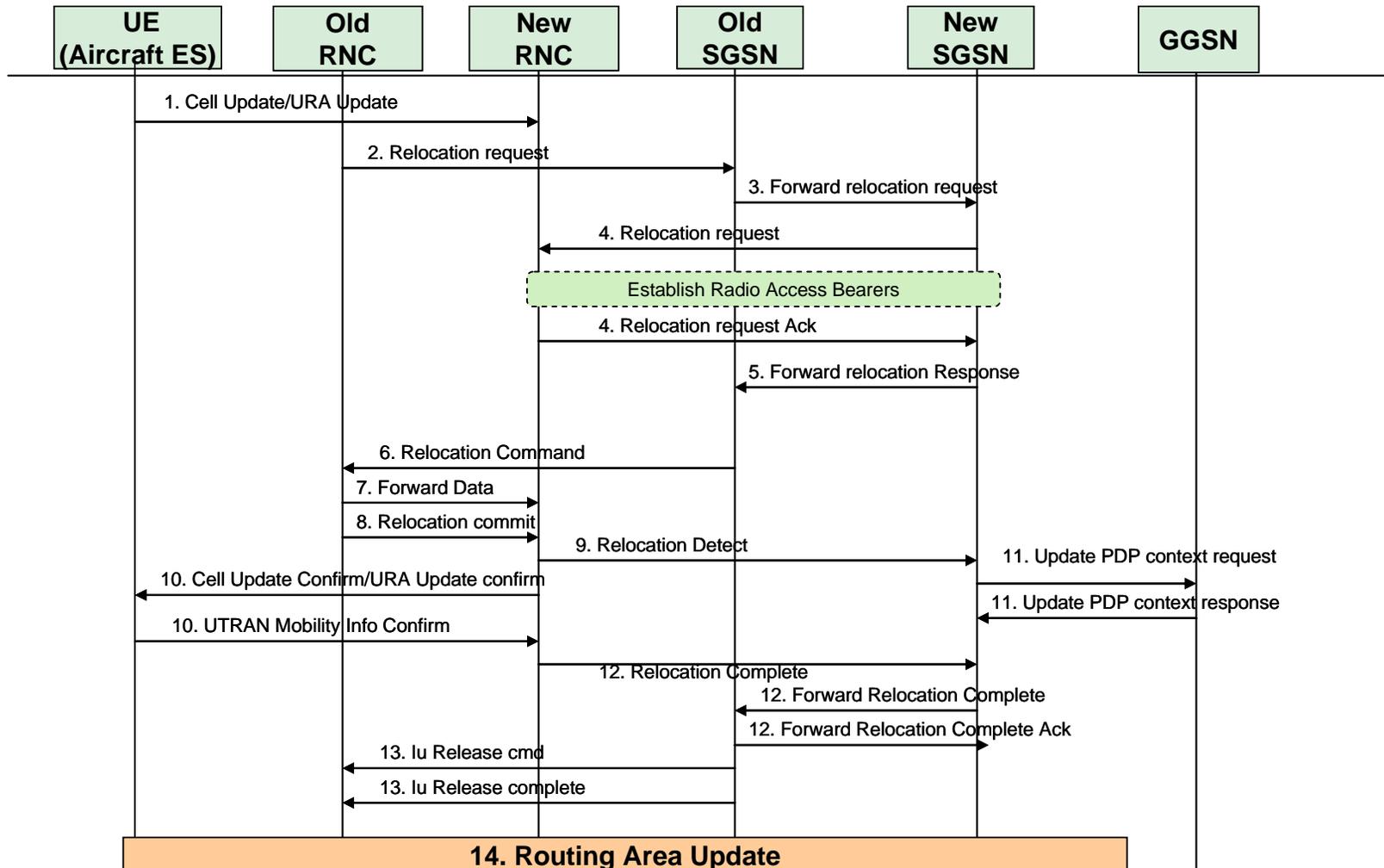


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# Cell/URA Update and RNC Relocation Request -- Scenario IV



- This sequence diagram shows the location update request mechanism when an aircraft enters a new SGSN/RNC service area in Scenario IV



- A full complement of WCDMA functional elements is required to provision COCR services
  - Not only the air interface and elements of the radio network controller are needed, but also elements of the core network such as HLR, SGSN and GGSN
  
- Results have impact on cost, certification and standardization
  - Because of the anticipated correlations between
    - Number of ground elements and cost
    - Required number of functional elements and complexity/risk of certification
    - Number of ground/protocol elements and standardization complexity/risk