Summary of the Operational View

- The importance of the operational view
  - Help clarify user demands
  - Consider all 4 C's
    - Customer
    - Consumer
    - Client
    - Caretaker
- What's in the system? (SBD)
- What are the interfaces? (IEM)
- How will we use it? (MSD)
- How will it grow or age? (OSD)

- Next time: The Functional View

Systems Engineering 0.101: A quick overview

Part 2: The Functional View

Create graphical artifacts first!

Create graphics first, text second when depicting artifacts of a system design.

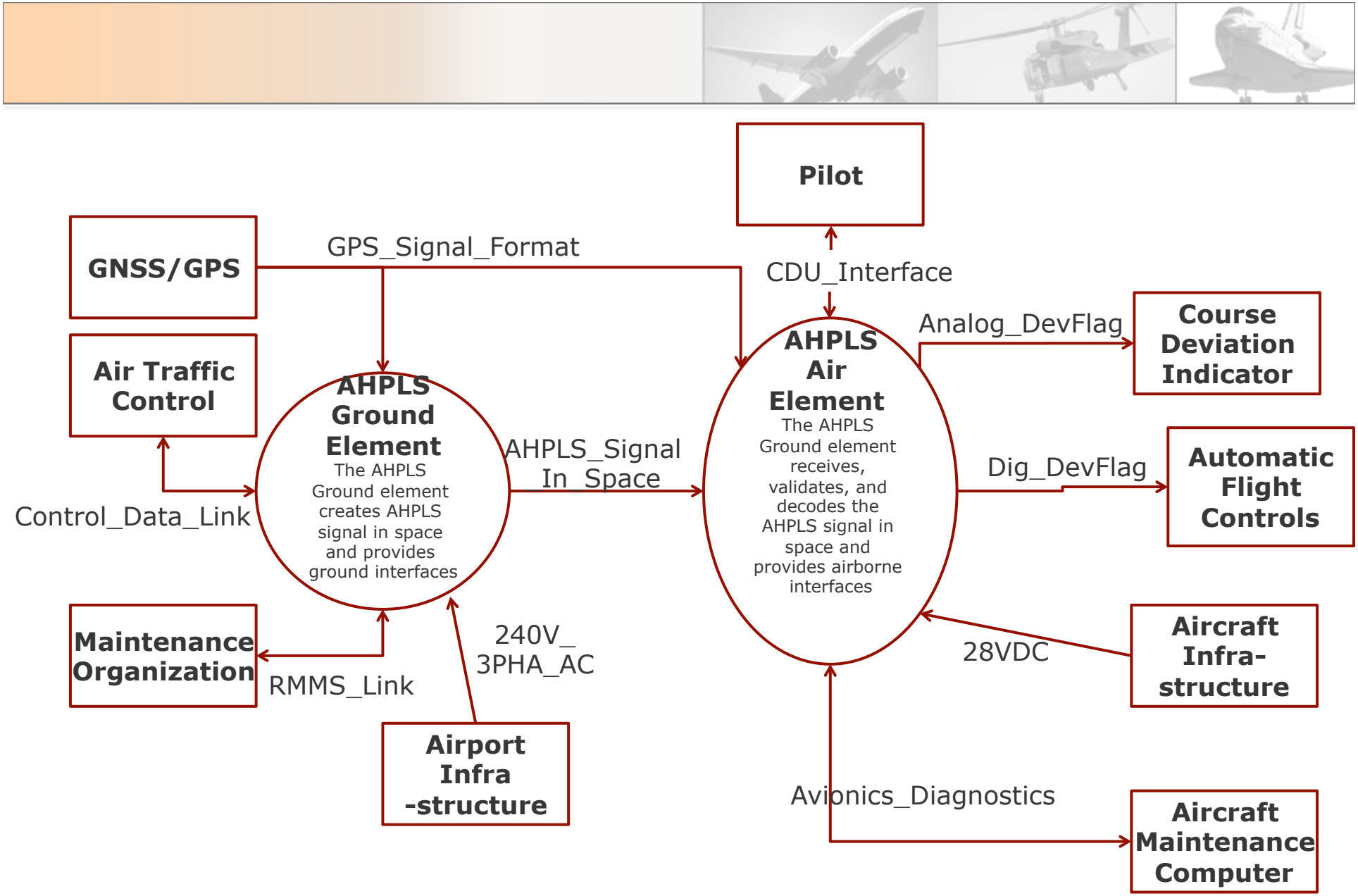
- **Graphics assist in communication with customers, coworkers and other stakeholders**
- **Text documents will flow from the artifacts.**
- **Heuristic: A picture really is worth 1000 words!**

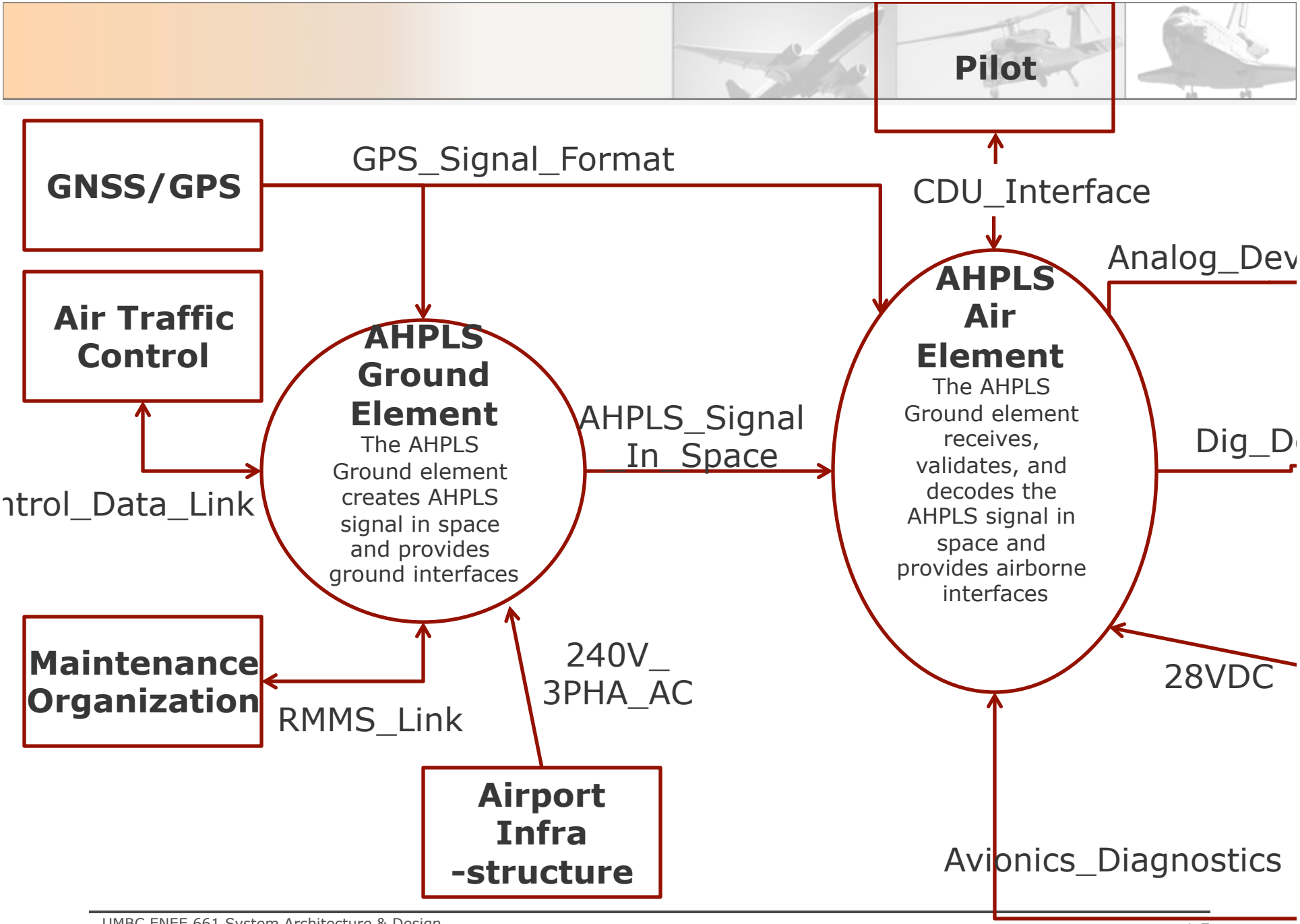
Functional data flow & control flow diagrams

- Data flow diagrams and control flow diagrams are the step below System Boundary diagrams
- Graphical depiction of interactions between functions
- Stay focused on the **functions**, not the **implementation**
- Stay focused on the **functions**, not the **implementation**
- Functions
  - Verb phrases, e.g., "Compute path deviations"
- Show data and control flows differently
  - Hatley-Pirbhai use solid & dashed
  - IDEF0 uses entry/exit point
- Define the interfaces in an Interface Table or Data Dictionary

Site Decomposition

- The process of breaking down the SBD is known as decomposition
- Usually, the next level is *functional*…
- …but sometimes the first level is decomposition to sites
- That's the situation for our AHPLS

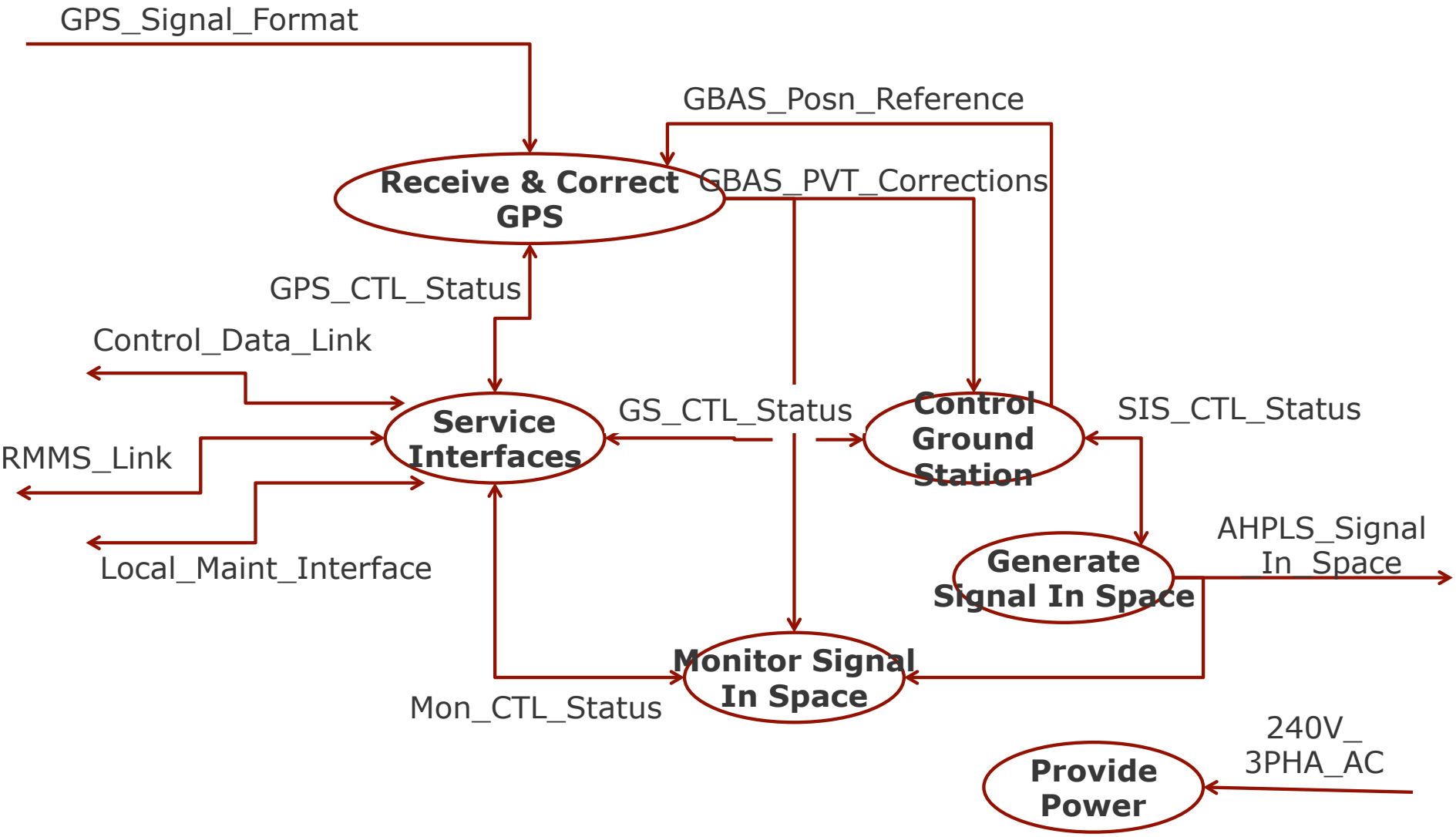


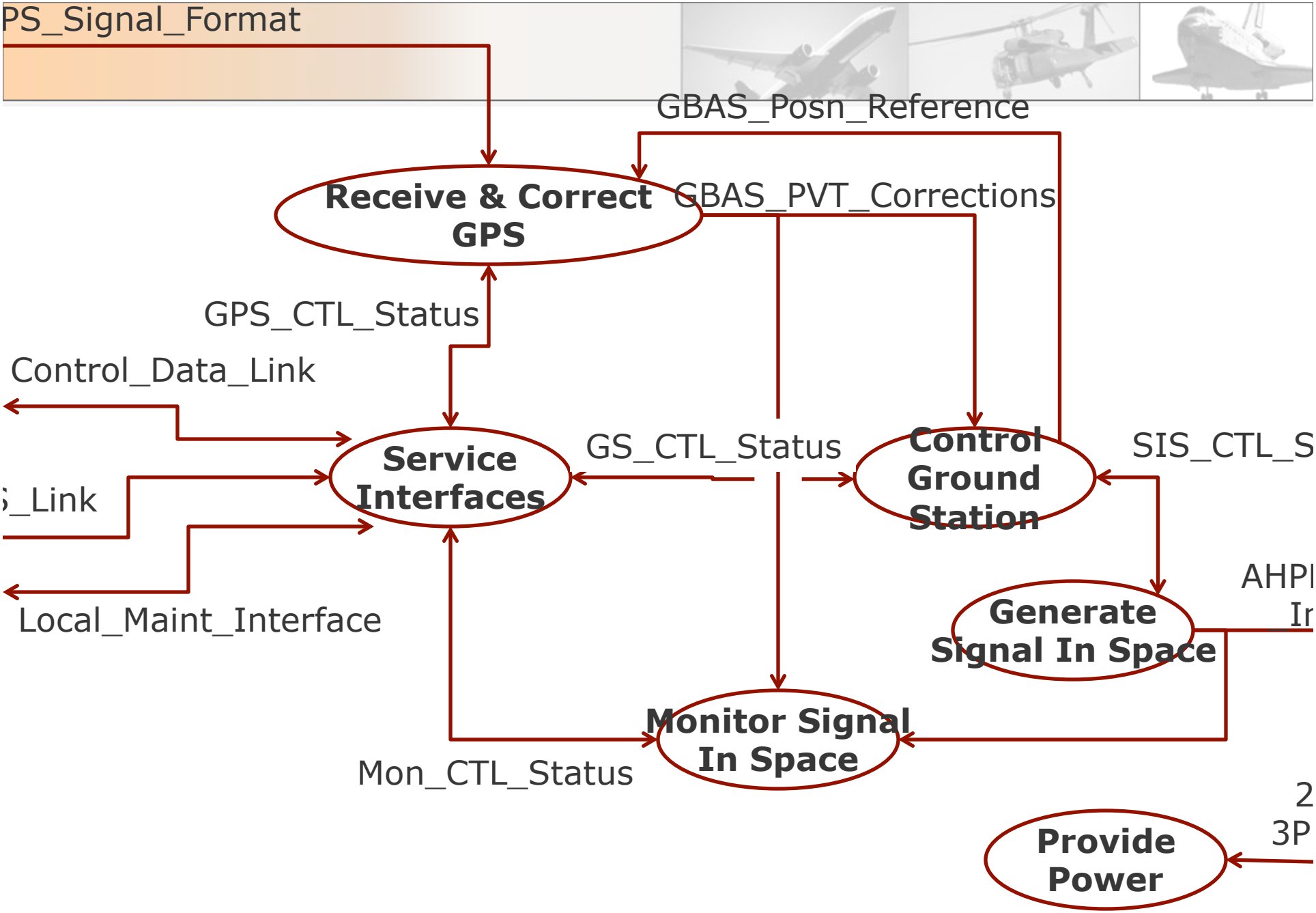


Functional Data Flow/Control Flow Heuristics

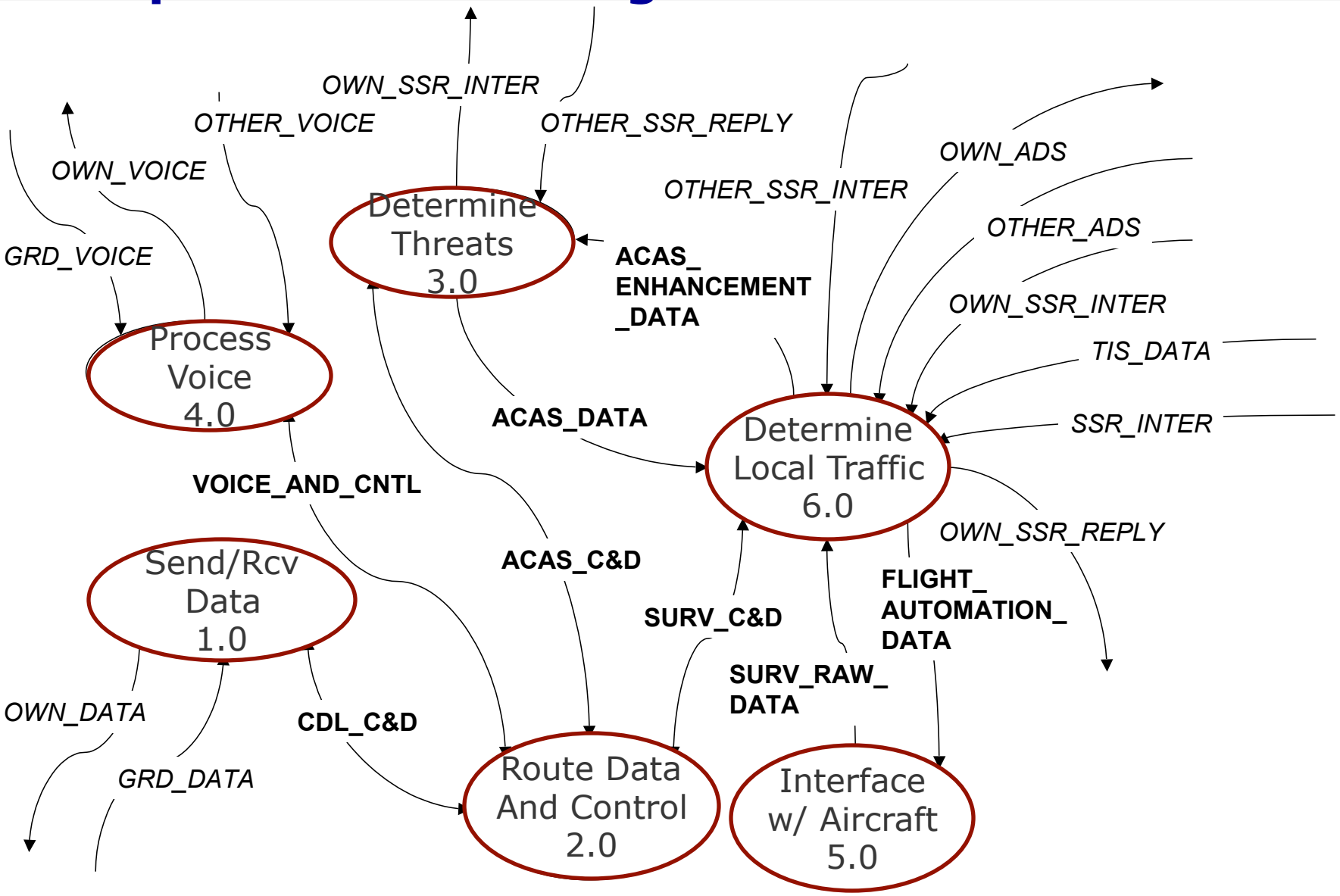
- **Heuristic**: If you haven't defined the interfaces, you don't know anything.
- **Heuristic**: One person's system is another person's component.
- **Heuristic**: Good quality interface specifications are simple, unambiguous, complete, consise, and focus on substance.
- **Heuristic**: Working documents should be the same as customer deliverables; that is , they should use the customer's language, not engineering jargon.

Ground DFD (first pass)



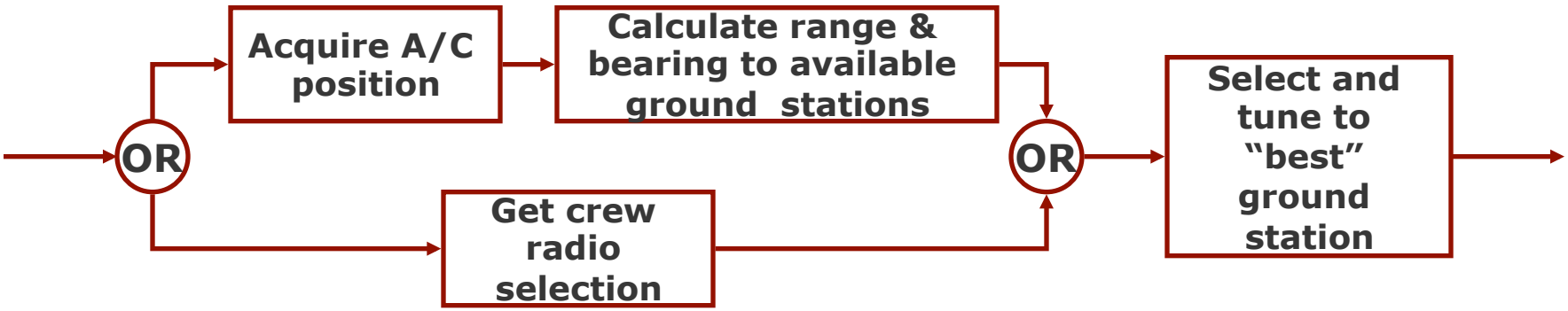


Sample Data Flow Diagram

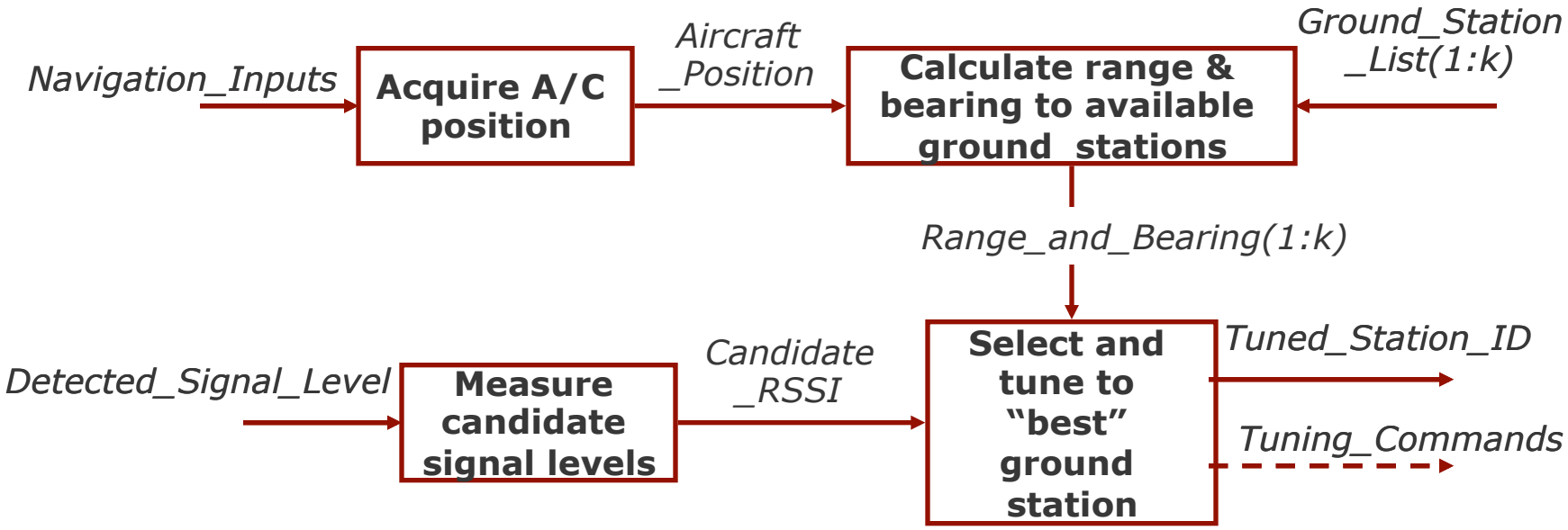


Functional Flow Block Diagram (FFBD)

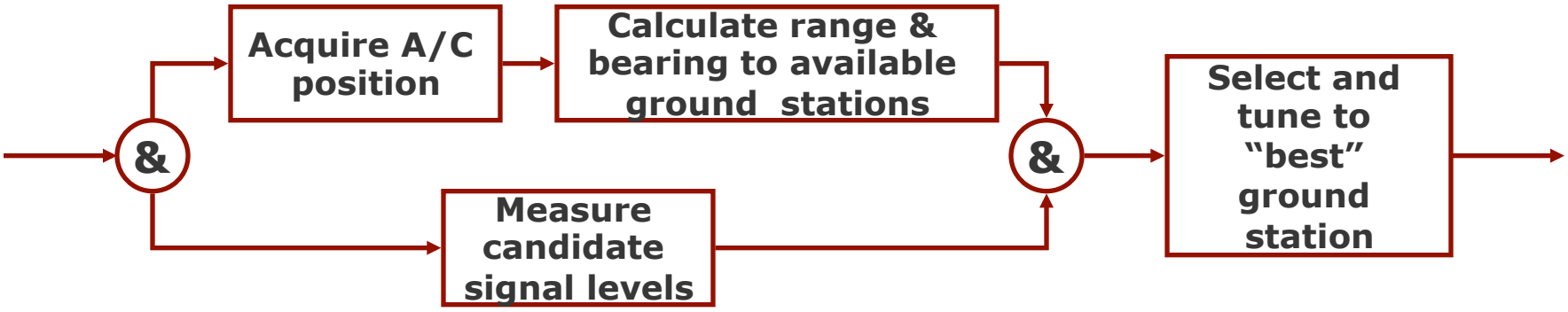
- **Purpose**: Depict serial/concurrent properties of the functionality
- **Design Goal:** Maximize concurrency
- **Consider:** Relationships between functions to determine dependencies
- **Do**: Consider sequence "left-to-right"
- **Don't:** Worry about data flows
- The FFBD is still a **static** model



Data Flow/Control Flow Diagram vs. FFBD



Data Flow / Control Flow Diagram



Functional Flow Block Diagram

Hints for working with FFBDs

- At higher levels of abstraction, functions tend to be **concurrent**
- At lower levels of detail, functions eventually become **serial**
- To determine concurrency, consider if functions can run independently (given necessary inputs)
- **Serial relationships** tend to impose more constraints on implementation
- Understand **why** functions are concurrent or serial and be conscious of the implications

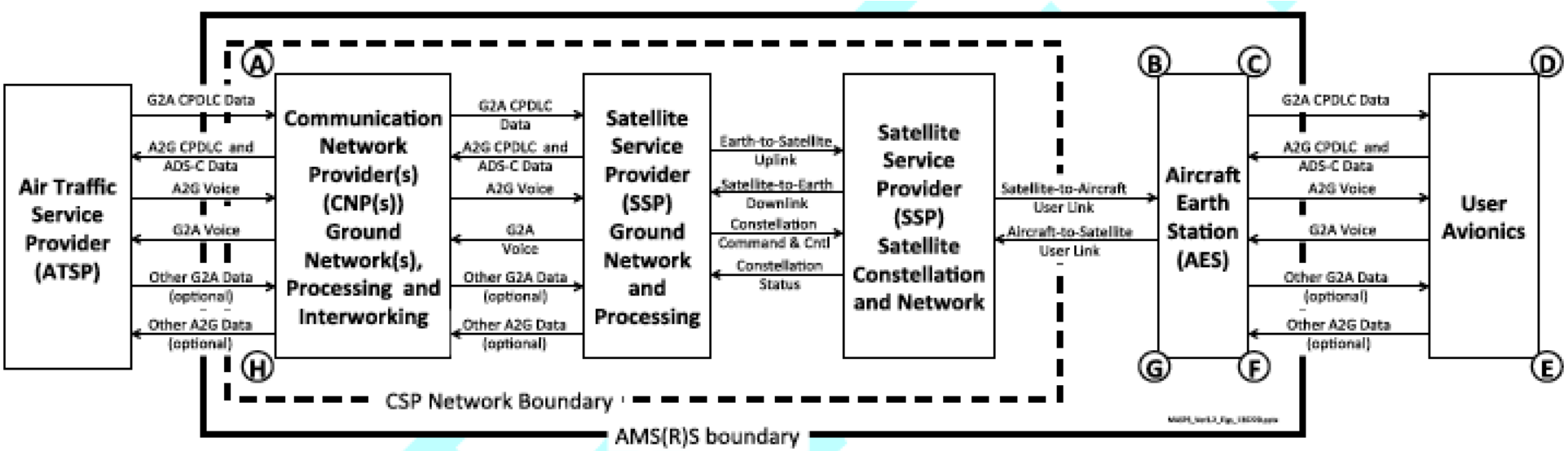


Figure 1-2: Notional AMS(R)S Partitioning

"Minimum Aviation System Performance Standard for AMS(R)S Data and Voice Communications Supporting Required Communication Performance (RCP) and Required Surveillance Performance (RSP) in Procedural Airspace" Washington, DC: RTCA, Inc., 2013.

A few words about user interfaces

- In the "up front" functional analysis phase
  - Consider what information must be presented
  - Consider what information must be retained
  - Consider what information must be input
  - Consider users' environments
  - Don't forget the caretakers!
- In the "detailed" functional analysis phase
  - Develop user interface command structure
  - This can be viewed as a functional hierarchy, taking the commands as functions
  - Apply advanced techniques (not covered in 450/451)
    - "Leave details to the experts!"

Functional Trade Studies

- Trade studies are **hard to do** at the functional level
- **Heuristic**: Do the hard parts first
- What do we trade?
  - Function **sets** defining different mission scenarios
  - Different functional decompositions of the same higher-level function
- Alternatives should span the range of potential solutions
- What are our metrics?
  - Number
  - Complexity
  - Reuse
  - Scaleability
  - Integrity/reliability
- The trade need not be explicit or detailed, but does need to be captured.
- **Heuristic**: Simplify, Simplify, Simplify!
- **Heuristic**: It doesn't exist if it isn't written down

Functional/architectural tradeoff example

0, 1, 3, 9

1,2, 3,4,5

		Functional Product Requirements - Operating Parameters						
Maximize, minimize, or target								
Customer Need	**Importance Rating**	Arch #1	Arch #2	Arch #3	Arch #4	Arch #5	Arch #6	Arch #7
ADS-B functionality	5	9	9	9	9	9	9	9
Advanced Surveillance Functionality	3	9	9	9	9	9	9	9
DSB-AM Voice	5	9	9	9	9	9	9	9
ATS Data Comm.	3	9	9	9	9	9	9	9
Good availability	3	9	3	0	1	3	9	3
Good continuity	4	9	3	0	1	3	9	3
Minimize interference to existing Sys.	3	3	3	3	3	1	3	1
Minimize susceptibility to existing Sys.	3	3	3	3	3	1	3	1
Upgrade of existing radio	1	0	0	0	0	0	0	0
Minimize Number of Antennas	4	0	0	3	3	9	1	9
Comp. wcurrent antenna placement	2	1	1	3	3	9	3	9
AOC Data Comm.	3	9	9	9	9	9	9	9
Minimize acq. cost.	5	0	3	1	0	3	1	1
Minimize installation complexity	3	1	3	3	3	9	1	1
Relative Importance		257	236	221	223	294	270	260
Target Range								

Things to consider

- **Heuristic**: Act on fact!
- Often the simple trade study will only show what you don't know.
- **Heuristic**: Know what you don't know.
- Be careful with your weighting, as it can change the results of table-based trades.
- **Heuristic**: The last time your solution is perfect is before you show it to someone else.