BOEING

747-8 Ground Wireless System

Best Practices for Ground Wireless Systems
(4 November 2009)

Introduction

- **e-Enabled airplanes require the implementation of GateLink wireless. This will allow the airlines to achieve maximum data transfer efficiency:**
  - Engine Health Management Data
    - Large size (up to hundreds of megabytes per flight)
    - Important for preventative/predictive maintenance and trending
  - Software Updates/Parts
    - The 747-8 uses wireless (802.11b/g) at the gate for staging LSAPs (Loadable Software Airplane Parts) on the airplane
  - Maintenance and Reliability Information
    - LRU errors and maintenance messages
- **The absence of GateLink at the airport in no way affects the operational capability of the 747-8. The operation of the 747-8 can be fully supported without wireless capability.**

802.11 b/g Basics

- **The 747-8 uses the IEEE (Institute of Electrical and Electronics Engineers) 802.11 b/g wireless communication protocol**
  - 802.11 b/g operates in the 2.4GHz ISM band
  - 802.11 b/g has a maximum theoretical throughput of 54 Mbps, typical speeds are much less
  - 802.11 b/g has three non-overlapping channels (1, 6, and 11) which should be used to minimize overlap with adjacent access points (i.e. if an a nearby access point is on channel 1, use channel 6 or 11)
  - Wireless performs best when there is a line of sight view between the communicating devices

Data Loading on the 747-8

- LSAPs and software updates can be dispatched to the 747-8 over the wireless communication link

- Parts will be staged on the airplane until they are dataloaded by a mechanic

- Engine data will automatically be transferred off of the airplane when a wireless link is available

- LSAPs and software updates/maintenance data can also be transferred with the help of a maintenance laptop in the event that a wireless link is not available

Typical Data Transfers

- This table show a sample of parts and data that will be periodically updated and downlinked.

LSAP Part	Freq	Nominal size
FMF Nav Database	28 days	23 MB
EFB Term Chart DB	14 or 28 days	450 MB*
Airport Map DB	28 days	10-20MB, 145 MB (max)
EFB Electronic Docs	6 months	100-200 MB
Future EFB applications	TBD	>500 MB
Downlink Data	**Freq**	**Nominal size**
EHM	Per flight	100-400 MB/flight
EHM events	Per engine event	50KB - 4 MB/engine
Security logs	1 to 90 days	up to 22.5 MB (to ML)
CPL (Continuous Parameter Logging)	Airline policy	70MB Max (10 hr flight)

* EFB Term Charts is a 3rd party provided application.

Can I Re-Use My Existing Gatelink Infrastructure?

- **Desktop BEGSS – Yes**

- **'Access Points can be set up to support multiple SSIDs.**

- **Each SSID has it own characteristics, including what kind of security will be used. But one Access Point can support these alternatives**

	747-8	777	787
TWLU	Miltope	Miltope	Honeywell
Wireless Protocol	802.11b/g	802.11b/g	802.11b/g
Reference Standard	ARINC 822	ARINC 763-3	ARINC 822
SSID	Determined by Airport ISP or the Airline configured in CIS AMI "GATELINK822" is typical	set in EFB Config File "GATELINK" is typical	Determined by Airport ISP or the Airline, configured in CIS AMI "GATELINK822" is typical
Wireless Security	WPA2/802.11i	No WEP or WPA	WPA2/802.11i
Authentication	EAP-TLS mutually authenticated EAP/TLS using X.509 digital certificates; Just being designed to likely use OCSP stapling over TLS for revocation checking	None	EAP-TLS mutually authenticated EAP/TLS using X.509 digital certificates; Requires the Gatelink AAA Server certs to be verified periodically on ground, and pre-provisioned to 787 via AMI.
Encryption	AES (recommended) or TKIP	None	AES (recommended) or TKIP

Antenna Location on the 747-8

- **The TWLU (Terminal Wireless LAN Unit) antenna height ranges from 32 feet 3 inches to 33 feet 7 inches depending on the weight of the airplane**
- **The antenna is located 35 feet from the nose on the crown of the airplane (location is marked approximately below by the red X)**
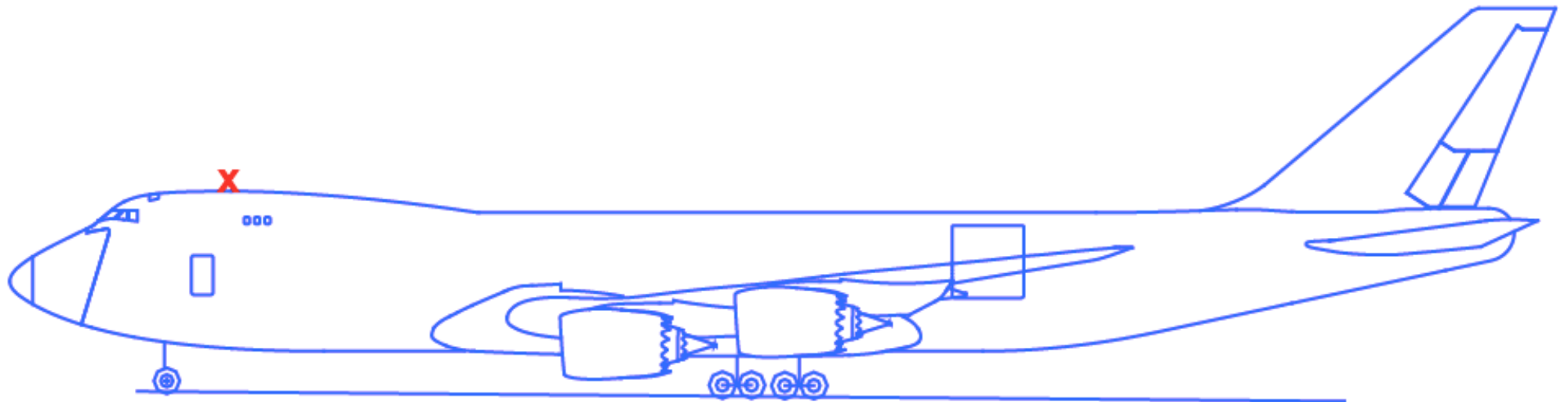
Antenna Basics

- Selection and the installation location of antennas on the ground side of the wireless system can have a significant impact on the performance of the overall system

- Directional antennas should be used where possible to achieve the most efficient use of RF (Radio Frequency) energy

- Omnidirectional antennas radiate equally in all directions, while directional antennas focus the RF energy in a specific direction

Antenna Basics Continued
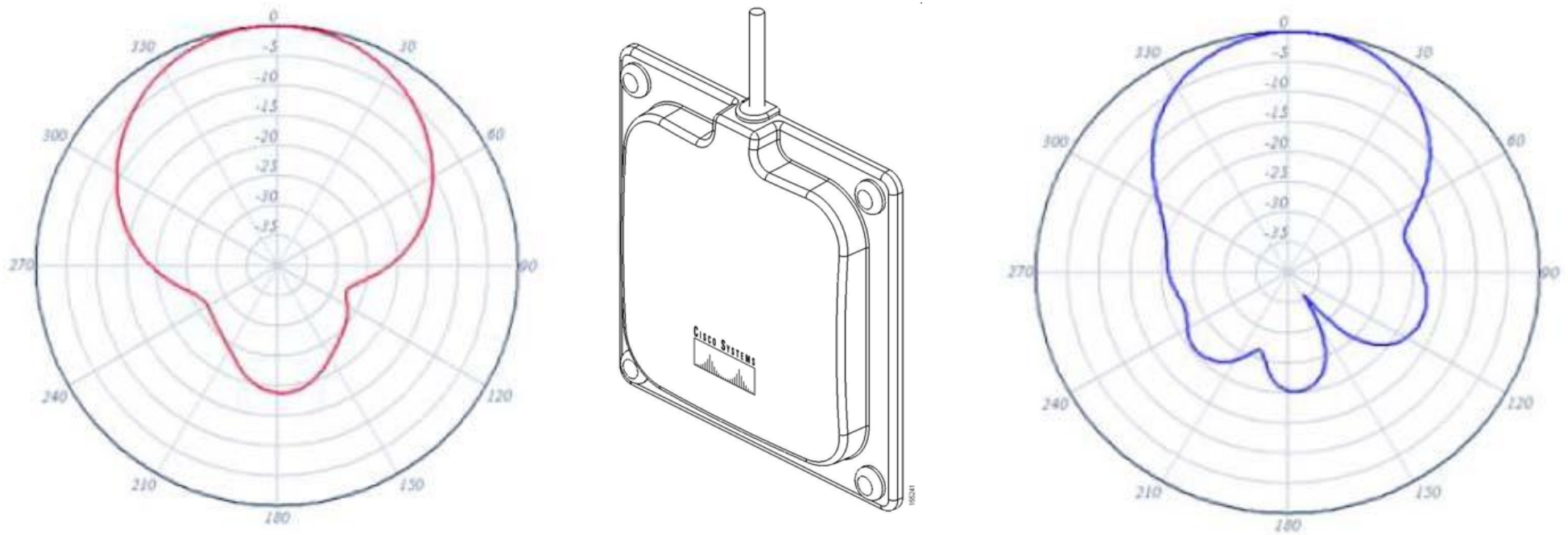
Directional patch antenna radiation pattern, azimuth (left), the physical antenna (center), and elevation (right)

Ground Side Antenna Installation

- **If at all possible the ground side antennas should be located such that they are pointed at the crown of the airplane with a clear line of sight view**

- **Elevation difference between the TWLU antenna and the ground side antenna should also be minimized**

TWLU Antenna

Gate Antenna and Access Point
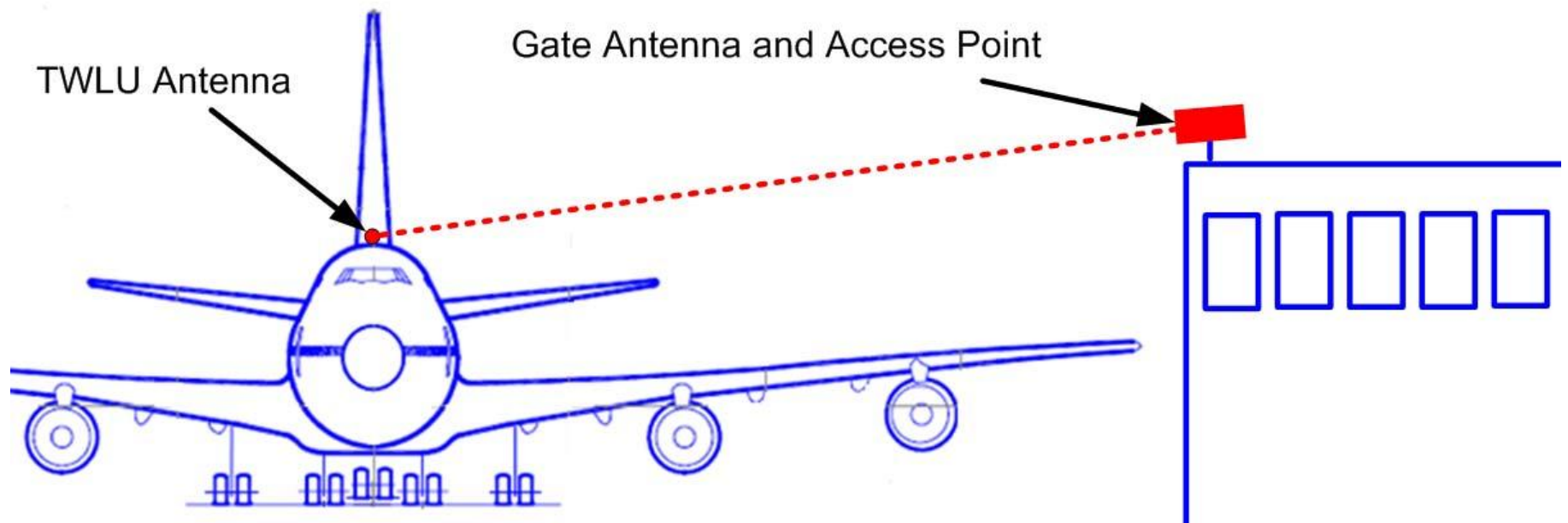
Ground Side Antenna Installation

- **Antenna coverage should be designed such that RF energy is used efficiently and not radiated in unwanted directions**
- **The number of airplanes per access point should be minimized**

Access Point

TWLU Antenna

Antenna Pattern

Terminal
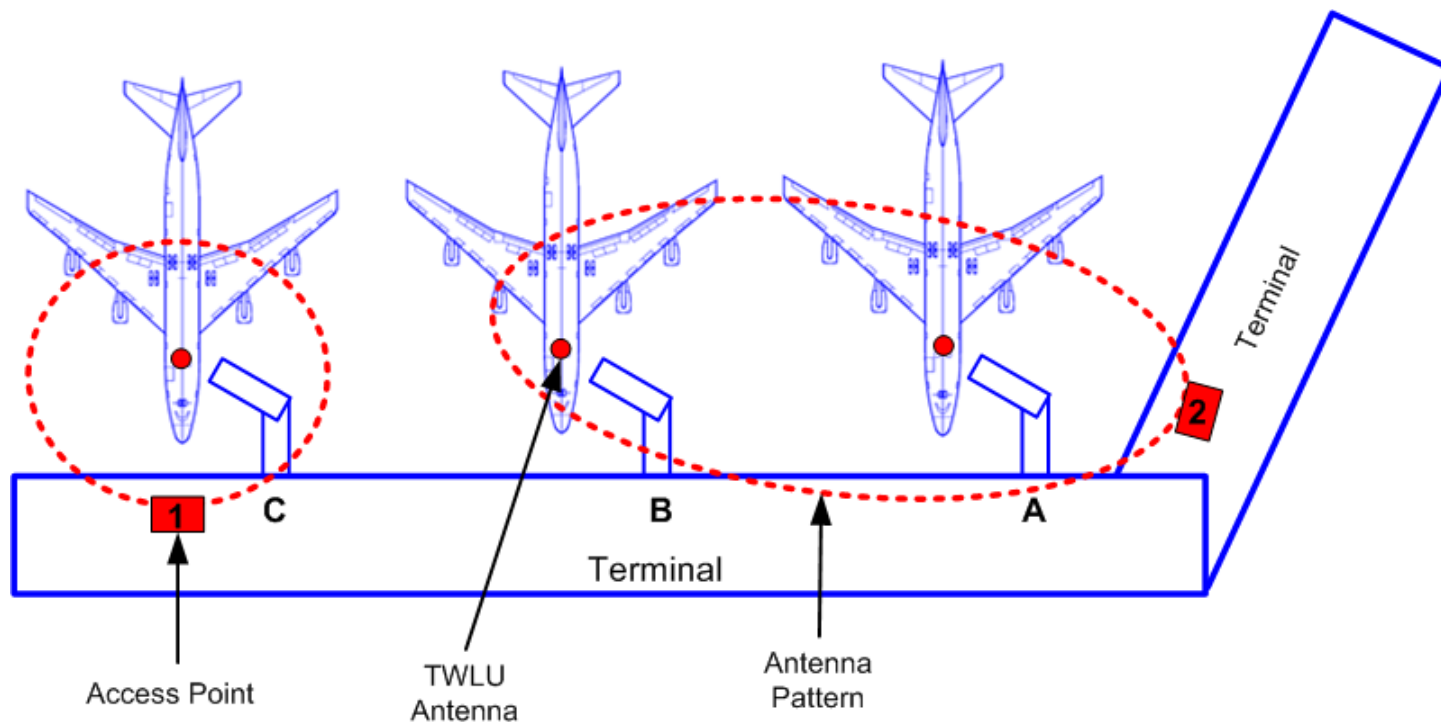
Summary

- **E-Enabling the 747-8 on the ground will allow airlines to operate more efficiently**

- **The 747-8 can still be operated without wireless capability**

- **802.11b/g are line of site technologies.**

- **Airports have significant RF energy. The time to begin coordinating and planning is now, to determine the location of antennas to support ground operation at both terminal gates and remote parking areas.**

- **Boeing can assist with the development of the wireless system of the airside. Contact 747-8 Terminal Wireless at (747-8terminalwireless@boeing.com) or timothy.m.mitchell@boeing.com)**

- **Boeing is assisting w/ the development of the standards – ARINC 763A, 821, 822, 830 and 839**