STANFORD UNIVERSITY – SUMMER 2014

Gogo Wi-Fi and the in-flight internet challenge

MS&E 238 – Final project

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Outline

1. Executive Summary

People are more and more connected and need to access Wi-Fi everywhere at any time. This observation is undeniably true and appears to cause big changes to happen in IT technologies. For instance, during the 2013 Google I/O conference, Google announced that they would soon release a version of Android Auto to enable drivers to stay connected in their car. In the past few years, Wi-Fi access has become more and more available in any type of transportation (buses, trains, etc.) but what about planes?

To answer the increasing demand of in-flight Wi-Fi Services, companies like Gogo have developed new technologies to provide internet services to airline passengers and have decided to tackle all the challenges associated with in-flight internet providing. Our team chose to manly focus this case study around Gogo since they are the most successful company in this area covering 80% of the US market and willing to conquer more.

However, big market share does not always mean big profits. Gogo's main issue is that this company has developed a great technology but is having a hard time generating significant margins with it. In this case study will try to explain and demonstrate that there are many challenges associated with in-flight internet services.

First, the technology has to be mature enough and we will show in the first part what are the main steps that were already accomplished, where we are today and what we could possibly expect in the years to come.

Second, the business model associated with the technology has to generate value quickly enough to ensure the growth of the company and the development of new products and services. In this section, we will ask ourselves if Gogo's business model is successful or not.

Third, beyond the technical and commercial challenges there is also the understanding of the aviation market which is the real key to success for a company like Gogo, and in this last part we will analyze more in detail what is Gogo's relationship with both airlines and aircraft manufacturers and how this could possibly be improved to create the ultimate in-flight Wi-Fi experience for passengers.

2. Technologies used worldwide to provide in-flight Wi-Fi

2.1. Background – The last 10 years

In the last 10 years Wi-Fi and other telecommunication technologies are evolving very dynamically. The main reason for this rapid growth is the advent of smart phones and other portable devices, e.g. laptops, tablets. Ten years ago only business people had the possibility to check or send emails while travelling. In contrary, nowadays most people cannot imagine a day without being connected to the Internet. This new trend is apparent mainly due heavy usage of social media. However, the way how people use mobile devices could have not been revolutionized without fast progress of ITC technology.

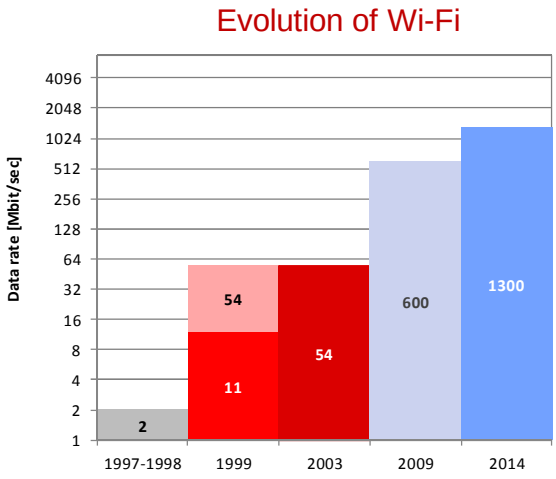

Figure 1 – Evolution of Wi-Fi technology [1]

Standard	Year	Modulation	Band [GHz]	Data Rate [Mbit/sec]
802.11ad	2015+	SC/OFDM	60	6912
802.11ac	2014	OFDM	5	1300
802.11n	2009	OFDM	2.4 5	600
802.11g	2003	DSSS OFDM	2.4	54
802.11a	1999	OFDM	5	54
802.11b	1999	DSSS	2.4	11
802.11	1997-1998	DSSS	2.4	2

Table 1 - Evolution of Wi-Fi technology [1]

As shown in figure 1 and explained in detail in table 1, data rates have increased exponentially during the last 10 years. In 2003 802.11g standard offered maximum raw data rate of 54 Mbit/s. Whereas 802.11ac standard, approved by IEEE in 2014, offers wireless rate up to 1300 Mbit/s.

2.1.1. Communication regulations

The inception of Wi-Fi technology resulted from the approval, issued in 1985 by the US Federal Communications Commission (FCC), to use ISM band without any license. Rules and regulations have been impacting the development and implementation of Wi-Fi technology ever since.

According to FCC [2] “The FCC’s current rules prohibiting use of cell phones on planes were adopted more than 20 years ago to protect against radio interference to cell phone networks on the ground. Technology that can be installed directly on an airplane is now available to prevent such interference and has already been deployed successfully in many other countries around the world without incident. This is purely a technical decision; it will, if adopted, allow airline carriers free to develop any in-flight phone usage policy they may wish, consistent with applicable rules.”

Therefore, as discussed above, it seems that regulations can hinder implementation of new technical solutions and in result the evolution of technology. Moreover, apart from the FCC there are also other authorities which have to approve use of new technology in aircrafts. Hence, airlines and bodies such as the U.S. Department of Transportation’s Federal Aviation Administration (FAA) have immense influence on which new ICT solutions can be implemented. “Ultimately, if the FCC adopts new rules, it will be the airlines’ decision, in consultation with their customers whether to permit the use of data, text and/or voice services while airborne. The FCC encourages prudent judgment and good etiquette in the use of cell phones and all electronic devices on airplanes. However, that is not within the scope of the FCC’s responsibility. The proposal provides the means for the airlines to decide whether to provide capability to access mobile wireless services and whether to limit such service to data and not voice calls.“ [2]

On the other hand, in October 2013 the FAA [3] “has determined that airlines can safely expand passenger use of Portable Electronic Devices (PEDs) during all phases of flight, and is immediately providing the airlines with implementation guidance”. Hence, this approach may give a positive effect in adopting cutting-edge technologies in aircrafts.

2.1.2. Communication technologies in aircraft

Wireless connectivity services are provided through software systems and hardware equipment. Nowadays, In-flight Entertainment systems (IFE) allow passengers and cabin crew to use their own mobile devices (i.e. tablets, laptops, smart phones) to connect to in-flight Wi-Fi and send and receive emails, surf the Internet, or even access corporate VPN. IFE systems employ wireless technology to enable bi-directional exchange of data between passengers and the IFE system.

Wireless technology has numerous advantages comparing to wired networks, such as:

- reduction of the costs of network infrastructure inside the cabin,
- no Ethernet cabling resulting in lower fuel consumption,
- personalized content thanks to connecting mobile devices

However, there exist some major technical constraints, namely “large number of wireless devices in a very narrow metallic tunnel like the cabin has a dramatic effect on network performance” [4]. Also, according to [5] “although it was proven that Wi-Fi and Bluetooth can

be used inside the cabin with no fear of interfering with navigational equipments, it is still difficult to use them in large numbers since performance degrades due to allocating them in a small area inside a metallic tunnel (i.e., cabin), which is full of different obstacles (i.e., seats). In addition, the normal way of setting these technologies is usually done through predefined identifiers (i.e., IP address) or a user key (i.e., Bluetooth authentication key). Both techniques don't match the constraints inside the cabin, where devices must be designed without any predefined identifiers and to be configured without any user intervention". Taking into consideration the fact, that the bandwidth of in-flight Wi-Fi is shared among all passengers using it, the overall service could be improved by increasing the bandwidth and lowering the latency of the network.

In-flight Wi-Fi system architecture is a typical multi-tier architecture and as shown in figure 3 it consists of three major layers:

- **DB layer:** data access layer provides interface between systems and databases. Business/Service layer can query database through methods implemented in this layer, which encapsulate database mechanisms using renowned libraries such as Hibernate, LINQ, etc.
- **Business/Service layer:** this layer implements business logic of the application, e.g. auto detection of Wi-Fi service provider, auto switching off all network connections during take-off and landing
- **Presentation layer:** provides the application's graphical user interface (GUI). It communicates with other tiers in order to display results of operations.

In-flight Wi-Fi systems process data "In Air" as well as "On Ground". This means that the system installed in the aircraft must maintain connectivity with the ground based systems.

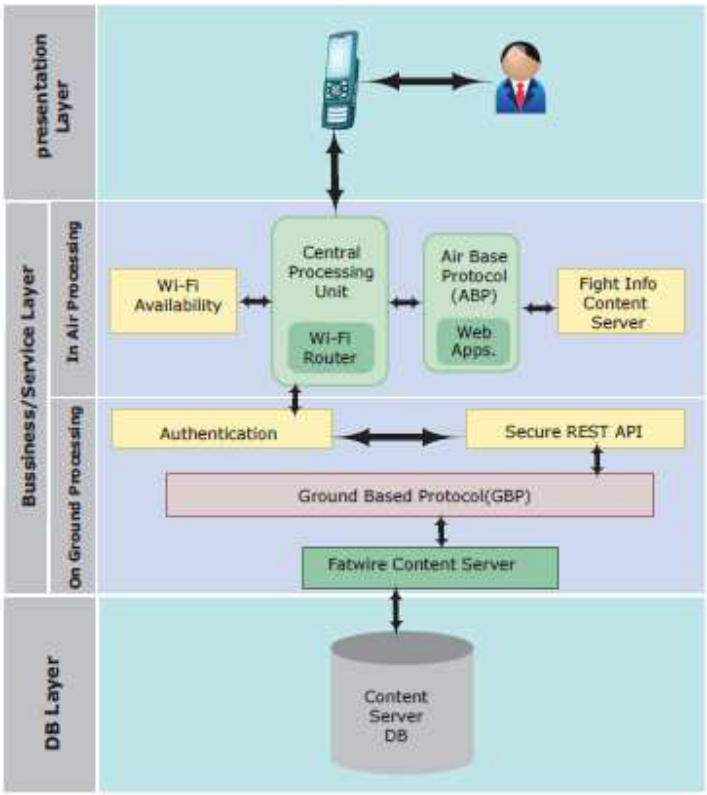

Figure 2 - In-flight Wi-Fi system architecture [6]

Modern in-flight Wi-Fi system architecture should be designed in such a manner as to allow passengers access in-flight Wi-Fi services through web application, as well as through mobile devices (e.g. smart phone, tablet) using dedicated mobile application. Ideally, according to the results of the survey explained in chapter 2.3.3, such a mobile application should be available for iOS and Android devices.

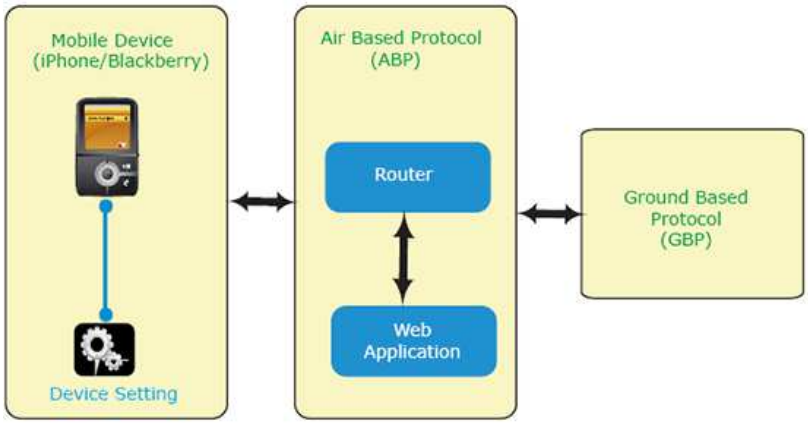

Figure 3 - Mobile application architecture [6]

2.1.3. Wi-Fi in different means of transportation

Wi-Fi technology has been implemented in different means of transportation. However, in contrary to provision of Internet access services in an aircraft, Wi-Fi infrastructure for ground transportation can be built at a lower cost. Ground public transportation (buses, trams), railroad transport and subway provide Internet access leveraging existing infrastructure or mesh networks.

Means of transportation are usually equipped with router with built-in modem. Router is connected to network using LTE/WiMAX/3G or satellite channel. On the other hand, mesh networks have high capacity rates and are suitable for fast-moving vehicles (up to 250 km/h).

2.2. State of the art – analysis of current technologies

Fundamentally, there are two approaches when one considers in-flight Wi-Fi: Air-to-Ground (ATG) and Satellite technology. Each of these technologies is explained in detail below.

2.2.1. Air-to-Ground technology

Air-to-Ground broadband network is a network of cell towers on the ground. These cell towers are terrestrial radio towers with network that transmits the signal to the aircraft as it travels. GoGo's ATG technology works as follows: "each cell site is typically divided into six sectors for additional coverage and capacity. As an aircraft travels across the U.S., it is automatically switched, and a hand-off is made, to the sector or cell site with the clearest signal" [7].

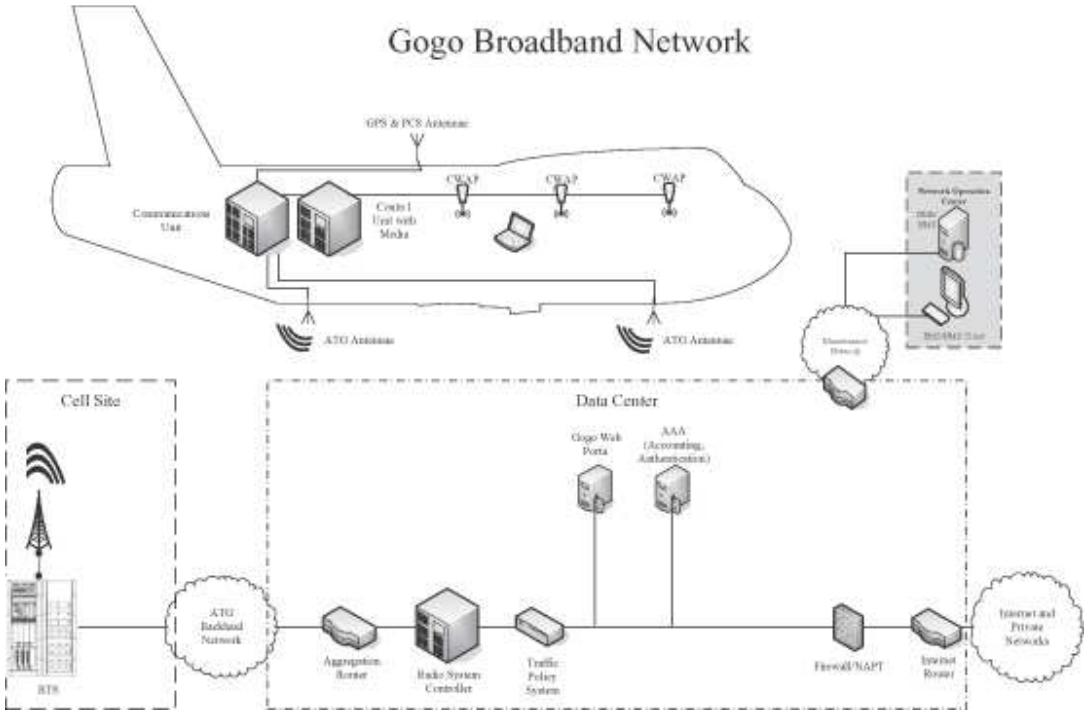

Figure 4 - Gogo's in-flight Wi-Fi ATG system architecture [7]

Architecture of the ATG solution is presented in the figure 5 and it relies on the following elements:

- **Cell Site:** more than 160 towers located on the ground, which are similar to a terrestrial cellular network.

- **Data Center:** consists of networked routers, switches, servers and firewall security devices. Servers in data centers are used for hosting in-flight as well as ground IT systems including applications and portals.

- **Airborne network:** a network in the aircraft, where data is distributed through the local Wi-Fi network that is maintained by airborne system. ATG Antennas are typically mounted on the bottom of the aircraft.

ATG broadband networks offer low latency. Also, cost of installation and maintenance is relatively lower comparing to satellite solutions. However, the coverage of ATG network is limited only to a small geographical area. Therefore, this solution is not suitable for long-haul international and transoceanic routes. Moreover, the bandwidth is low and data rates are only up to 3.1 Mbit/s for ATG and 10 Mbit/s for ATG-4 (2nd Generation ATG).

2.2.2. Satellite technology

Satellite technology is based on radio connections transmitting signal from the satellite to the aircraft.

Gogo offers Iridium-based systems, which are supported by a network of 66 satellites in low-earth orbit. Gogo states, that “in addition, we offer SwiftBroadband satellite-based high-speed data communications equipment, which is supported by three geostationary (Inmarsat I-4) satellites in orbit approximately 22,000 miles above the earth” [7]. Also, Gogo plans to adopt new technologies such as Ka-band and 2Ku satellite technology.

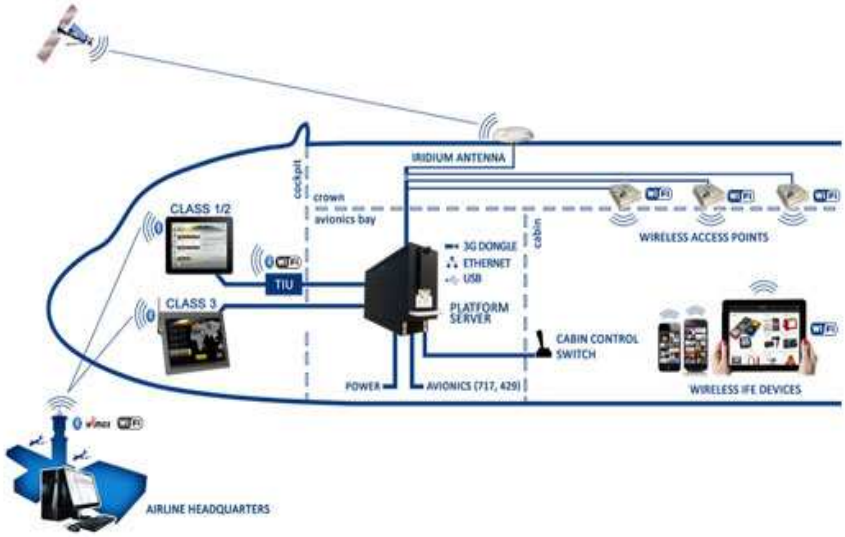

Figure 5 - Iridium satellite system architecture [8]

Satellite-based networks have high throughput up to 70 Mbit/s. Furthermore, such solution offers coverage over a large area, thus it is designed for aircraft serving transoceanic and international routes. However, the initial costs of installation are high and it is a high latency solution.

Nevertheless, both in-flight Wi-Fi solutions: ATG and Satellite-based, do not guarantee full security. Gogo doesn’t provide encrypted connection between in-flight access points and personal devices. Although, Gogo supports VPN, SSL and SSH access, data sent through un-encrypted Wi-Fi connection is not secure. The risk could be mitigated, if Gogo introduces encrypted Wi-Fi connection. However, this may happen only if Gogo implements a technology suitable for multiple users using in-flight Wi-Fi at the same time. Clearly, higher data transfer rates would help to make it possible.

2.3. Technical trends for the future

2.3.1. 802.11n (4G)

The 4th Generation (4g) Wi-Fi standard is becoming more and more common. It supports both 2.4 GHz and 5 GHz band, therefore it is compatible with 802.11 b/g/n and 802.11a/n standards. Furthermore, 802.11n offers much higher data rates, up to 600 Mbit/s, as compared to previous standards with capacity limits of 11 or 54 Mbps.

2.3.2. 802.11ac (5G)

The 5th Generation (5G) Wi-Fi standard was approved by the IEEE in January 2014. The new standard 802.11ac improves the speed of the connection by providing data rates up to 7 Gbit/s in the 5 GHz band. By implementing new standard, in-flight Wi-Fi providers will offer better quality of the connections as well as can serve more passengers simultaneously.

2.3.3. Other trends

- **Ground-to-Orbit (GTO):** is a proprietary technology owned by Gogo. This new technology will be capable of delivering bandwidth at a rate up to 60 Mbps to the aircraft. GTO solution is a hybrid solution, which combines ATG and satellite technology. Ku satellite technology will be utilized to receive signal in the aircraft, whereas ATG technology will be used to transmit the signal from the airplane.
- **Mobile devices and wearables:** currently more and more people use mobile devices. However, we can predict, that in the near future wearable devices will be also ubiquitous. Tablets and smartphones make up 67% of the devices being used by Gogo WiFi users to get online in air. Tablets are the most popular device to connect (35%), followed by laptops (33%) and smartphones (32%).

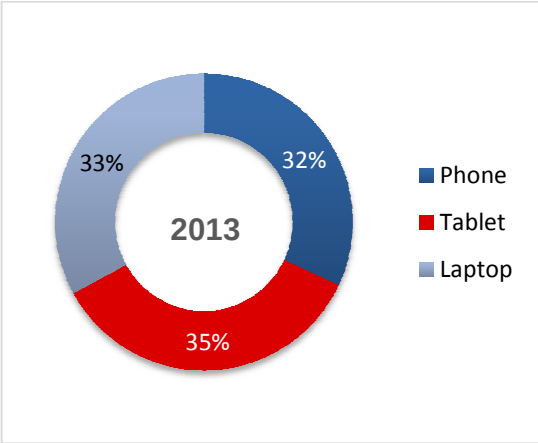

Figure 6 – The most popular ways to get online in air using Gogo services

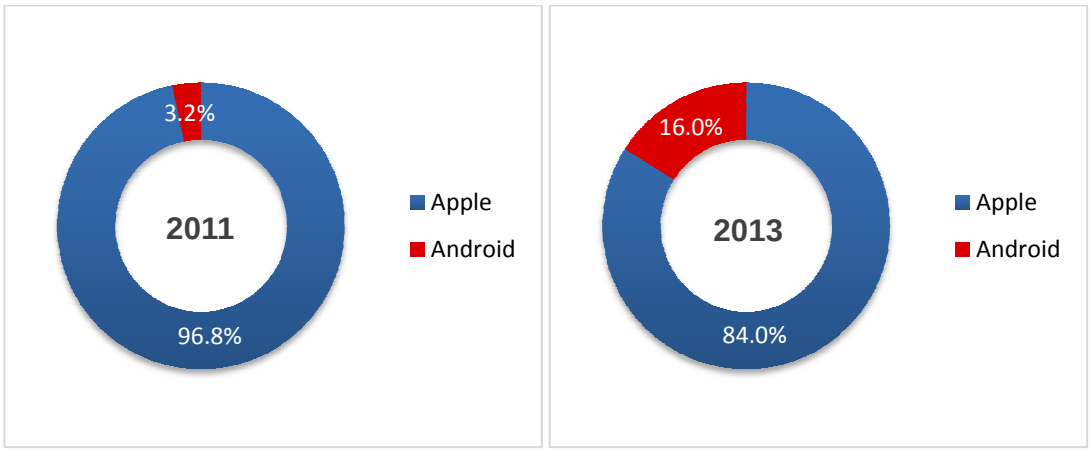

Figure 7 – Which operating system gets more action in-flight

- **Internet everywhere:** provision of access to the Internet around the globe is a market where Google as well as Facebook see huge potential. Both companies have introduced projects aiming to deliver internet access to locations not yet connected – project Loon and Internet.org respectively. Whether harnessing the drone technology or less technically sophisticated balloons, both solutions can enable passengers to have access to the Internet in aircrafts.

3. Gogo Wi-Fi business model

Gogo is a global leader of inflight connectivity, with more than 80% of market shares, and a pioneer in wireless inflight digital entertainment solutions. Using Gogo'exclusive products and services, passengers with Wi-Fi enabled devices can get online on more than 2,000 Gogo equipped commercial aircraft. In addition to its commercial airline Business, Gogo has more than 6,300 business aircraft outfitted with its communications services. Inflight connectivity partners include American Airlines, Air Canada, AirTran Airways, Alaska Airlines, Delta Air Lines, Frontier Airlines, United Airlines, US Airways , Virgin America and since recently Japan Airlines. More to come in 2015 like Lufthansa, Icelandair and Air France. Inflight entertainment partners include American Airlines, Delta Air Lines, Scoot and US Airways.

In a short period of time Gogo has become one of the most popular ways that the flying public is connecting online while on flights. Taking account that they achieved major milestones in their business like exclusive Air-to-Ground 3MHz patented in 2006, broadband coverage at 30,000 feet above the earth since 2008, and a new technology increasing download speed up to 70 mbps Gogo has been awarded World's 50 Most Innovative Companies in 2012 and this expanding technology startup has collaborated with Breakthrough Technologies since 2011 to provide development assistance.

Here are few exciting and critical Business facts confirming its leadership position: [9]

- American Airlines selected Gogo as the in-flight connectivity provider on 30 new Bombardier CRJ-900 NextGen aircraft,

- Gogo launched "Delta Studio" with Delta Air Lines - a custom wireless in-flight entertainment product leveraging the Gogo Vision Platform to offer a unique in-flight entertainment experience to Delta passengers,

- Gogo received certification from the FAA to install Gogo Vision as a stand-alone product for commercial aircraft,

- British Airways announced the launch of Future Air Navigation System solutions and Swift Broadband airtime service plans for the business aviation market,

- Gogo received an STC from the FAA and certification from the Japanese Civil Aviation Bureau (JCAB) to install its Ku-band satellite technology on Boeing 767-300 and 737-800 aircraft, bringing a total STCs for international aircraft to seven,

- Gogo received regulatory approval to provide Ku-band satellite connectivity service for aircraft flying over the eastern and western regions of Russia.

3.1. Stakeholders: Partners – Customers – Competitors

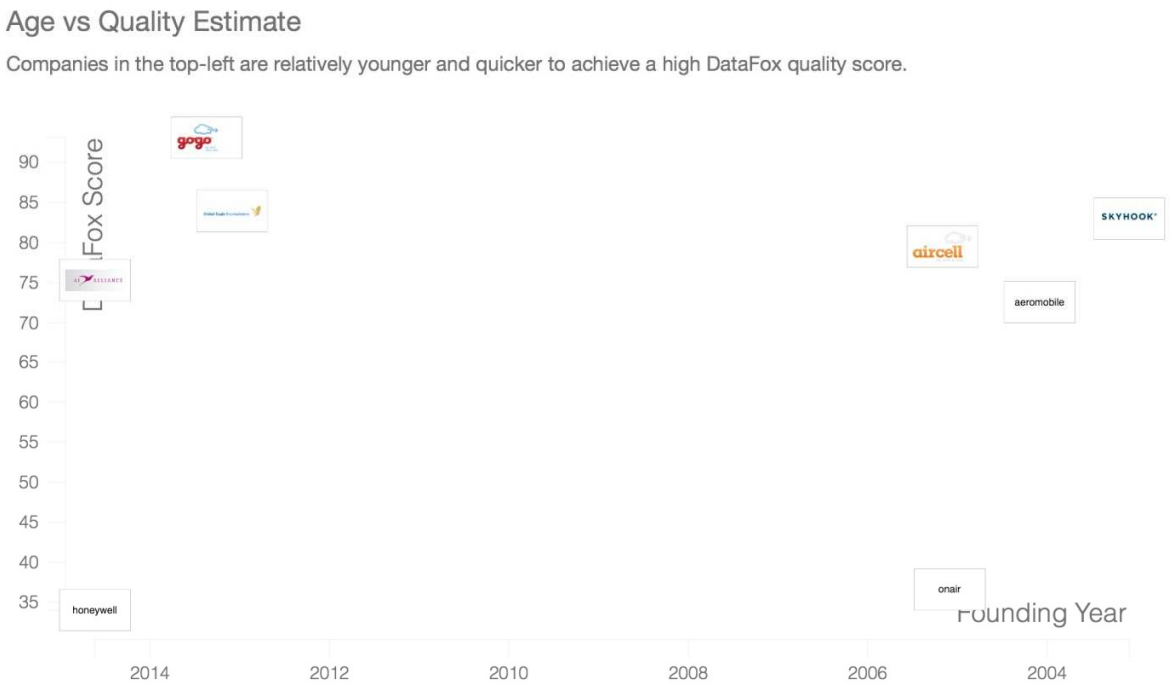

Figure 8 - Full picture of market of the in-flight Wi-Fi Business (Datafox, July 2014) [10]

The tool Datafox is showing an interesting main picture of the market of the in-flight Wi-Fi.

- **Who are the Gogo suppliers?**

As explained in Part 1, you have 3 technologies used for in flight Wi-Fi.

Ground	Satellite	Hybrid
Air to Ground (ATG)	Ku	Ground to Orbit (GTO)
ATG-4	2 Ku[1]	

Figure 9 - Gogo Wi-Fi technologies

- **Who are the Gogo customers?**

As stated earlier in the paper, the current and the future airplanes companies listed above contribute significantly to the growth of Gogo Wi-Fi.

A recent study from In-Stat study claimed that only 10% of the flyers were using wireless internet in flight, but the number can rise around 25% on popular routes for business travelers. This study is expecting as well an increase of popularity over the next few years, generating 1.5 Million USD for airlines by 2015 [14].

Additionally, according to the ICAO, 3 Billion people used air transportation in 2012 and it should reach 6 Billion by 2030, according to the current projection [11]. The prospect of the in-flight Wi-Fi is having a great Revenue projection counting the fact that nearly 30% of the travelers will use the Wi-Fi, especially if the prices decrease [11].

Figure 10 - Airlines working with Gogo

More data showing the distribution of the Wi-Fi available in airlines is listed by the newspaper Business Traveler of September 2012. [12]

To complete these data, we thought it would be representative to let you know the List of the top 10 Airports representative For In-Flight Wi-Fi, according to a Forbes study in the US of June 2010, [13].

1. Hartsfield-Jackson Atlanta Airport (ATL)
2. Dallas Fort Worth International Airport (DFW)
3. Orlando International Airport (MCO)
4. Minneapolis-St. Paul International Airport (MSP)
5. LaGuardia Airport (LGA)
6. Los Angeles International Airport (LAX)
7. John F. Kennedy Airport (JFK)
8. Detroit Metro Airport (DTW)
9. San Francisco Airport (SFO)
10. Salt Lake City Airport (SLC)

- **Who are the Gogo competitors?**

Even Gogo is boosting the market with its 80% market shares, the market stays competitive. Indeed, the main competitors on the market are On Air, VIA SAT and Aeromobile.

On air, a fully owned subsidiary of SITA, originally incorporated as a joint venture with Airbus is based in Switzerland and has operations internationally. On air is focused either on airlines but also on cruise ship since 2005. In 2014, they had equipped 22 airlines. They are offering to flyers an internet connection of 56 kbit/s and provide On Air services with an integrated GSM. Recently they have equipped the innovative plane Solar Impulse.

Via Sat is an American company making 1 Billion Sales. They are specialized in global satellite services for government, commercial aircraft and cruises.

Aeromobile, part of Panasonic, is based in UK, since 2010 and generates 2 Million USD of revenues. Their technology is based on a component of Panasonic's Global Communications services.

Honeywell Aerospace, the largest manufacturer of aircraft engines and avionics is based in the US, generating 31 Billion USD Revenue is acting in many segments of aviation. On a bigger scale, they have the objective to lead the market in a near future with an innovative Wi-Fi Satellite connection.

The competition is aggressive when we start to speak about the technologies used by each of them.

In-flight broadband remains a nascent market and new competitors and technologies will emerge as the industry continues to evolve. The existing relationships with airlines, flexible technology platform (including the use of ATG-4 and satellite technology going forward) and brand awareness with travelers will enable for the moment Gogo to maintain and extend their dominant market share domestically and expand internationally.

Figure 11 - Air to ground (ATG) antennas owned by Gogo in the United States

3.2. SWOT Analysis of the Gogo Company

- **Strengths and weaknesses of the company**

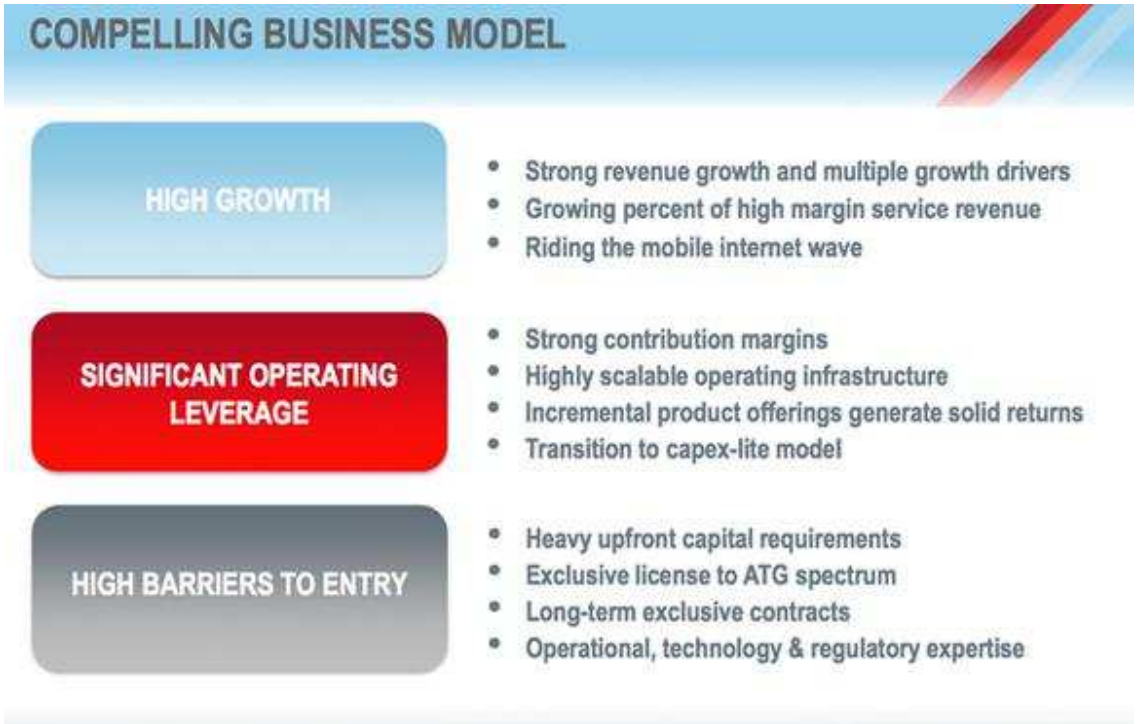

Figure 12 - Gogo Business model (Source: Gogo Investor Relations, Presentation slides) [15]

STRENGHTS A mature technology ready to pivot in case of necessity, a solid network of customers.

WEAKNESSES A connection which can be slow depending the airlines and service not yet offered in long distance flights over the ocean

OPPORTUNITIES The customers' needs are really existing and will be increasing fast over the coming months and years.

THREATS The technologies are changing very fast, so Gogo has to innovate constantly, which is costing quite a lot of money, in order to keep their leader position.

We also need to take in consideration the security risks in case of terrorist attack. The data have to be secured enough.

3.3. Financial model: NASDAQ, shares, profits

- **Gogo's stock exchange quotation, cash flows**

$16.24* **0.41** **2.59%**

* as of August, 5 2014

Figure 13- 11 Million shares of common stock at 17 USD/share [16]

Latest important Business facts on the financial health of the company Gogo Wi-Fi:

- **11th August 2014**, Record quarterly revenue **up 25 percent to 99.5 Million USD**.
- **7th August 2014** Gogo Receives Certification from the FAA to Install Gogo Vision as a Stand-alone Product for Commercial Aviation with or without Connectivity.
- **30th July 2014** Gogo Inc. Closes 75 Million USD Credit Facility Add-On to its existing $248 million credit facility arranged by Morgan Stanley. Gogo intends to use the proceeds of the debt financing for general corporate purposes

During the second quarter 2014 we could observe the following consolidated financial results

- Revenue increased to 99.5 million USD, up 25% from 79.4 million USD in Q2 2013.

- Operating expenses, including cost of revenue, increased to 110.4 million USD, up 25% from 88.5 million USD in Q2 2013.

- Adjusted EBITDA for Q2 2014 was 3.1 million USD, down from 3.8 million USD for Q2 2013, as a result of increased investment as Gogo continued to expand internationally.

Company Financials

Revenue	70,754,000 USD
Net Income	-14,477,000 USD
Total Assets	419,198,000 USD
With Total Liabilities	$264,173,000
Stockholders' Equity	-$477,326,000

And a Gross margin of 50%

These outstanding news and related figures are confirming the fact that Gogo is currently matching with the Sales previsions and its alignment of investors' expectations. Indeed, Gogo expect total revenue of 400 million USD to 422 million. They anticipate that increased spending for STCs at CA-ROW for the roll out of their satellite connectivity solutions will bring its full year adjusted EBITDA toward the low end of the 8 million USD to 18 million USD range. So the share of Gogo itself should remain a good investment for the next couple of months.

- **Who are the intermediates between the service they provide (in-flight Wi-Fi) and the money (spent by airline passengers)**

The major actors of the business plan are the following: the Airline, the Airplane Manufacturer, the Satellite Operator and the Mobile Network Operator- MNO. The passengers, in this case are the customers, are the prime members of the value chain. The service user also represents a player equally relevant and essential to the business model once the final user of the service is where almost always the revenue flow comes from. Two business models have been identified as Single Model and Split Model. There is an insertion of a new player called AirCom Provider, whose idea approximates a virtual provider that does not possess clients of their own, that is why it plays the role of a service provider.

The Figure 14 is representing the single model which money flow begins between the existing relationships of the passenger with their ground service provider.

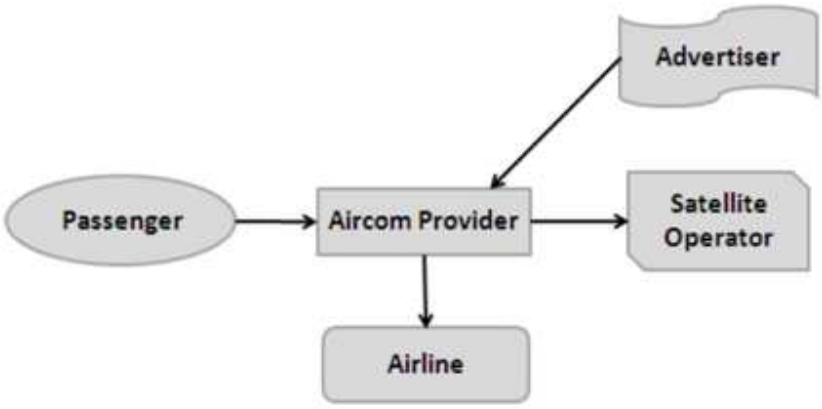

Figure 14 - Single model with a relationship between Passenger and AirCom Provider [17]

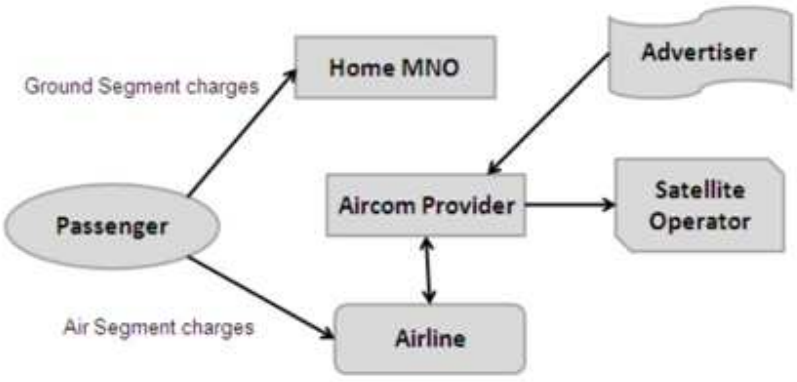

Figure 15 - Split model : Double Passenger relation with Home MNO Airline [17]

On the split model, on the figure 15, this is based on a double relationship of the passenger with their ground provider and with the airline. In this case a real time onboard billing system would be the most suitable. For the existing Satellites Internet services, Single Model has been mostly used. The way of charging passenger can change according to the interest of the airline and primarily with the manner in which the service is offered. Basically there are two connectivity environments offered to the passenger. The service can decide to offer a Wi-Fi Hotspot or with a PicoCell based on mobile access technologies.

Charging the passenger through their old relation with their ground provider has shown to be more advantageous than starting a new relationship between the passenger and the air service provider.

With a Wi-Fi Hotspot onboard, this idea does not make any sense since the system is not related with a mobile telephone network and does not exists on a pre-existent relationship. For that, the model used in this case continues to be in a single way, once the passenger pays for the service just for one player. Meanwhile, a difference is which agent receives this money flow, and in this case comes to play the AirCom Provider.

Other point to observe is the moment when the charge is made. The use of ground providers implies that the payment will be made in a monthly account or in other way, according to the previous agreement made with the passenger. Anyway, it is always charged after use. In the case of the AirCom Providers, the payment is done onboard, normally through accessing the home website of the service and using a credit card.

In the case of ATG technologies until now just Wi-Fi environments are available. Nevertheless, not all providers use Single Model, because there are cases in which the service is offered for free. In this case the business model is more complex, there are several enterprises involved and paying for the service with their respective revenues, sometimes it can only be marketing, clients' fidelity or even partnerships.

When the passenger is charged, he follows the same procedure of the Satellite model providing Wi-Fi, it means, the money flow goes from the passenger directly to the AirCom Provider. The difference here is the absence of the Satellite Operator making the business model simpler.

Even though the Split Model presents advantages like the possibility that the service provider can be autonomous in defining charges for passengers this system hasn't been used until nowadays. It has been observed that charging a passenger in different accounts is not recommended since the user does not feel comfortable when he has more bills to pay.

Regarding prices, each airline has slightly different rates, so the customers can check prior to their flights the individual website of the airline that they are flying for updated costs figures.

Some examples of Gogo packages from gogoair.com are the following:

- 5 USD/ Hour, 16 USD/ 24 hours in-flight access
- 49 USD/month unlimited accesses on any Gogo partner airline, the best value for frequent flyers. [18]

➢ **How do they generate profit? Do their margins enable them to grow as fast as they would like?**

Operators interested in equipping an aircraft with airborne Wi-fi capabilities may find the cost to be around 100,000 USD. [19]-[20].

Successful service providers view the monetization opportunities as a pyramid, or set of layers (refer to Figure 16).

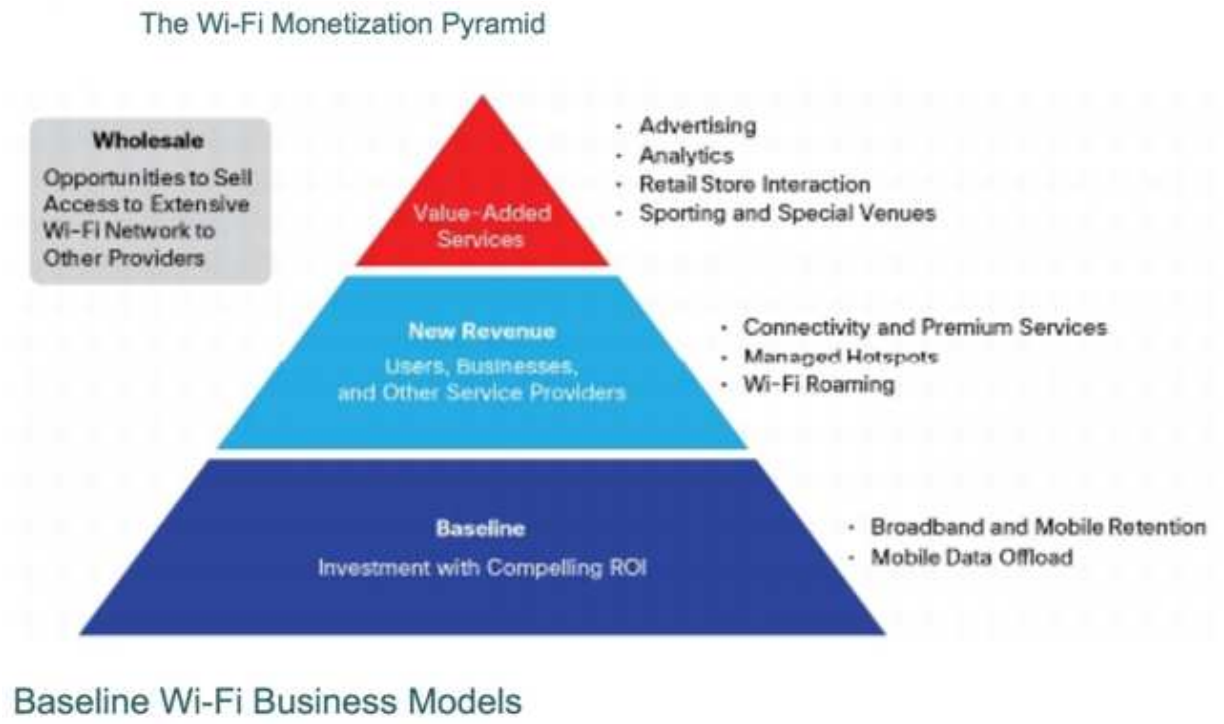

Figure 16 - Wi-Fi monetization pyramid

The core layers of Wi-Fi monetization opportunities in the pyramid, starting at the bottom, include:

• **Baseline:** Using Wi-Fi for broadband retention or mobile data offload offers a very compelling return on investment (ROI), largely based on cost reductions, to justify further investment in other layers of monetization.

• **New revenue:** Taking advantage of the Wi-Fi network deployed in the baseline layer to offer premium connectivity services, managed hotspots, or Wi-Fi roaming offers opportunities to generate significant new revenue from Wi-Fi.

• **Value-added services:** Increasingly new opportunities are emerging to take advantage of the Wi-Fi network developed in the previous layers to provide new and innovative services related to advertising, location, analytics, retail store interactions, and special venues such as sporting facilities.

Many service providers are now bundling access to a public Wi-Fi service with their broadband or mobile services, typically at no additional cost. Cisco research reveals that operators see significant immediate retention benefits in the first several months after introducing the bundle, followed by an ongoing 10- to 15-percent reduction in customer churn.

➢ Connectivity and Premium Access

Although public Wi-Fi may be increasingly free, there are still opportunities to charge for Wi-Fi access. Cisco mobile research found that people are still paying for access in "expense-account-friendly" locations such as hotels, airports, and trains. Equally, providers are making a business in selling Wi-Fi access at sporting venues and selling subscriptions or vouchers to their Wi-Fi networks.

To combat free Wi-Fi access, many providers now offer an added fee for premium access. Many places now offer a premium service that provides faster speeds and better quality of service (QoS), particularly targeted to rich-media applications such as video.

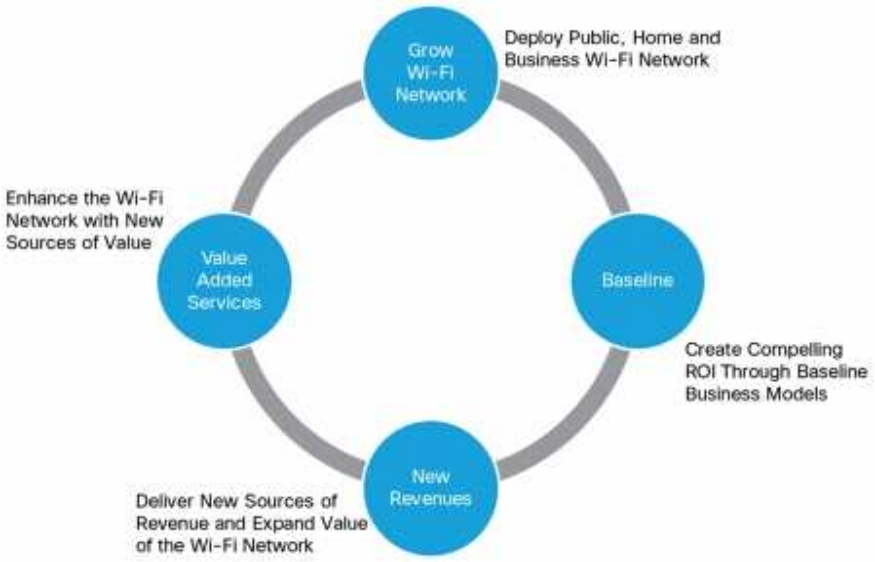

Figure 17 - Enhancing Wi-Fi services with premium packages [20]

4. Potential pivot in Wi-Fi providers' strategies

4.1. Improving the way technology interfaces with aircraft

4.1.1. Solving regulation issues with authorities once for all

In order to ensure the success of any in-flight Wi-Fi provider company, the first thing to deal with is the controversial aspect of the technology. Indeed, in aviation business people worry about security and safety a lot and implementing Wi-Fi on board might cause unexpected failures.

Some people think Wi-Fi antenna could enable terrorists to high-jack a plane from the ground or could have a negative impact on the plane's avionics. For this reason, it is extremely important for companies like Gogo to work hand in hand with aircraft manufacturers and regulation authorities to prove to their customers (the airlines) that their technology is safe and secure [22].

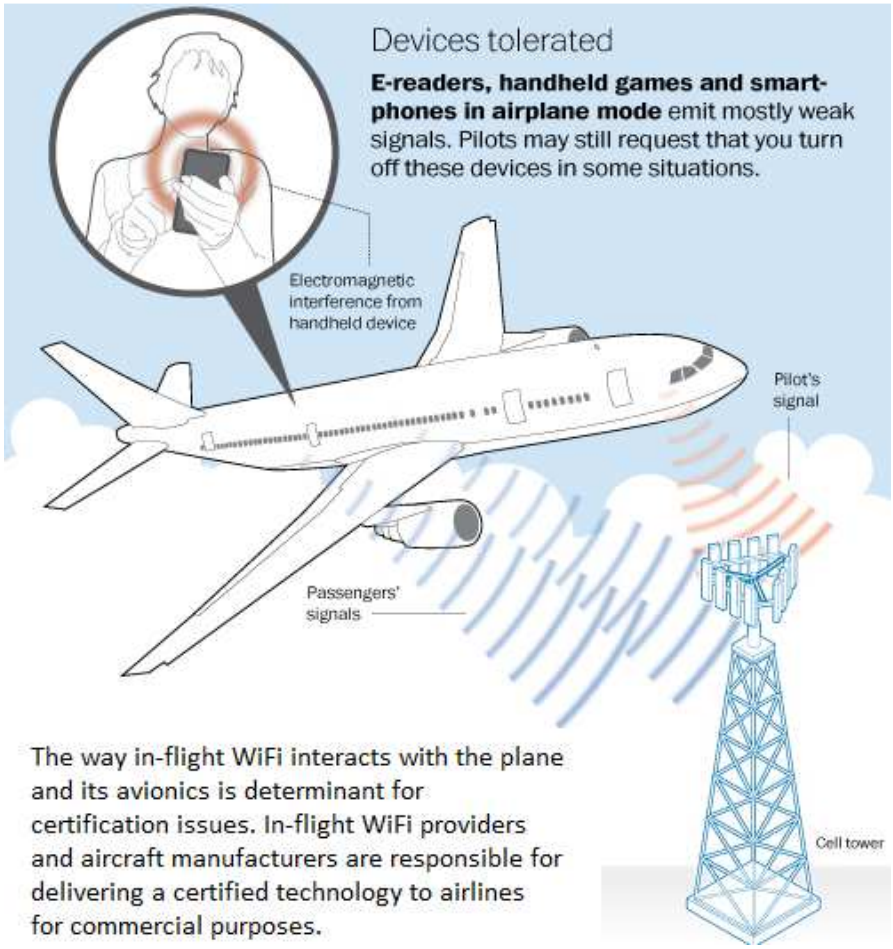

Figure 18 - The importance of in-flight Wi-Fi certification in partnership with aircraft manufacturers [23]

Improving the way the technology interfaces with the aircraft is certainly one of the biggest priorities for Gogo. Even if the airborne equipment used to enable in-flight Wi-Fi services ensures mobile phones emit very low power signals, as well as prevent any signals leaving the cabin, approval from aviation safety bodies, such as the European Aviation Safety Agency (EASA), requires very rigorous testing. As with any new technology for any aircraft, the necessary permissions are only granted when there is demonstrably no risk to safety and this demonstrability has to happen in flight which is why a partnership with an aircraft manufacturer becomes extremely important.

In-flight Wi-Fi providers do not have planes available to be operated for certification tests and they do not have test pilots contrary to aircraft manufacturers like Airbus or Boeing. For this reason, similarly to On Air which is one of the main Gogo competitor, in order to have regulatory approvals from over 100 countries and be able to operate over five continents and the world's oceans [24] a strong partnership with an aircraft manufacturer has become a must to succeed in this area. It is not by chance if On Air has a joined venture with Airbus. They are aware that improving the way their technology interfaces with the aircraft can make them become a leader on the European market.

4.1.2. Decreasing costs by improving cooperation with aircraft manufacturers

Besides the fact that a partnership with an aircraft manufacturer is necessary for certification issues, we could imagine this partnership going beyond a simple agreement for testing and safety demonstration. Indeed, as shown in figure 19, there are many components that are necessary to both in-flight Wi-Fi technology and aircraft navigation. What if aircraft manufacturers and Wi-Fi providers could figure out a way to merge their skills and produce a one and unique product satisfying both needs?

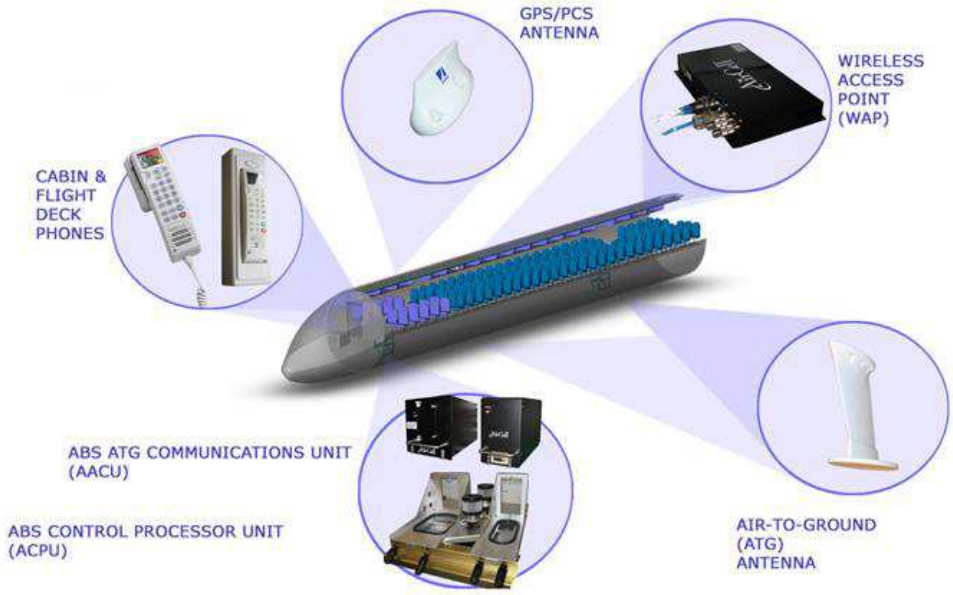

Figure 19 - Elements of Wi-Fi technology which interacts with the aircraft's architecture [25]

- **Cabin & Flight deck phones:** the technology which is used for in-flight phone calls is very different from the one used for in-flight Wi-Fi. For airlines, it does not really make sense to enable their passengers to have both phone call services and Wi-Fi services when for instance Skype could use Wi-Fi and enable phone calls. A partnership with aircraft manufacturers could enable a company like Gogo to discuss directly with cabin equipment suppliers and make sure that in-flight Wi-Fi plays a central role in the decisions made and items chosen for the cabin.

- **GPS/PCS antenna:** currently all aircraft in service have a GPS antenna that is primarily used for navigation but it could also be used by in-flight Wi-Fi providers. The problem is that this antenna is not designed at first for Wi-Fi services and when a company like Gogo wants to use the GPS coordinates, they need to add on some of their equipment to the airplane device which increases weight and therefore the operational cost of the plane. We could imagine that a stronger partnership between Gogo and an aircraft manufacturer could reduce the number of additional systems that Gogo has to implement and would thus reduce the operational cost of any Wi-Fi enabled plane.

- **Wireless access point (WAP):** because airplanes are very complex systems with many wires and metallic pieces that could interfere with any types of waves, in particular Wi-Fi waves, the location of WAPs in the cabin requires a very precise and accurate knowledge of the cabin architecture. In this context, a company like Gogo would have strong interest in improving the way its device interfaces with the airplane and the best way to do this is certainly to work hand in hand with an aircraft manufacturer or a cabin equipment supplier.

- **Air to ground (ATG) antenna:** all airplanes already have their own antenna in order to communicate with the control tower on ground. If in-flight Wi-Fi providers were able to use this already existing device to communicate with Wi-Fi towers on ground they would no longer need to develop and add their own antenna to airplanes it would considerably reduce their costs.

- **AACU and ACPU:** same thing for the communication unit and the data processing unit. There are several of these devices on board a plane (redundancy is for safety purposes) and if a company like Gogo was able to use one of this already existing unit for Wi-Fi services, they could reduce the costs for the airlines by making the plane lighter and thus cheaper to operate.

In the end, improving the relationship between aircraft manufacturers and in-flight Wi-Fi providers could considerably reduce the production and development costs for this technology. However, if it is obvious that such a stronger partnership would benefit to Gogo Wi-Fi, does it necessarily mean that aircraft manufacturers are ready to get involved in this kind of business?

4.2. Will Wi-Fi providers partner up directly with aircraft manufacturers?

Recently, some rumors about GoGo partnering up with Boeing to have in-flight Wi-Fi technology implemented directly on aircraft at factory has become more and more persistent [26].

4.2.1. In-flight Wi-Fi providers' point of view

Wi-Fi providers would no longer need airlines agreement to implement Wi-Fi on board. It would be implemented directly at factory and therefore would be on board of a more significant number of planes. Indeed, if we look at the type of contract Gogo has with its bigger customer Delta Airlines, they do not equip their entire fleet as shown in figure 20 because it takes time to implement the technology on board. Airlines usually wait for their aircraft to be retrofitted or have some serious on-ground maintenance to equip it with in-flight Wi-Fi.

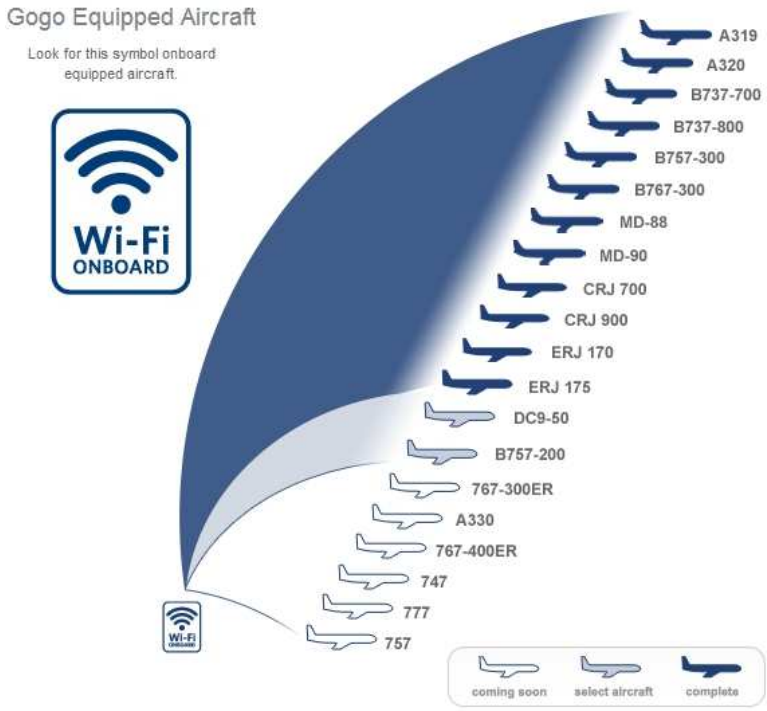

Figure 20 - Delta Airlines fleet equipped with Gogo Wi-Fi [27]

As we can see on figure 20, only the oldest type of aircraft of Delta's fleet (A319, A320, …, ERJ 170, ERJ175) are all equipped with Wi-Fi. The most recent ones (DC 9, B757, …, B777) which have not been retrofitted or which have not gone through intensive maintenance checks or maintenance work are not equipped with Wi-Fi because implementing Gogo's device onboard would cause the airplane to be unavailable for several weeks. Indeed, implementing Wi-Fi requires time during which the plane is on ground and does not generate any profit for the airline. For this reason, airlines usually schedule Wi-Fi systems implementation when the aircraft is already on ground for maintenance or cabin retrofit. This way they can maximize the number of hours their planes spend in flight and thus maximize their profit. For this reason, even if the contract Gogo has signed with Delta says that 100% of Delta's fleet will be covered, it may take years to get there.

If airlines were able to get in-flight Wi-Fi equipment directly at factory, then Gogo would sell as many Wi-Fi equipment units as Boeing sells plane. It would give them access to a very significant number of planes all over the world (not only in the US) and would put an end to a scenario where airlines which have a contract saying 100% of their fleet will operate Wi-Fi have only half of their planes equipped with the technology. A look at figure 21 shows that the number of new planes sold in 2032 will be much higher than the number of planes which will be part of the retained fleet.

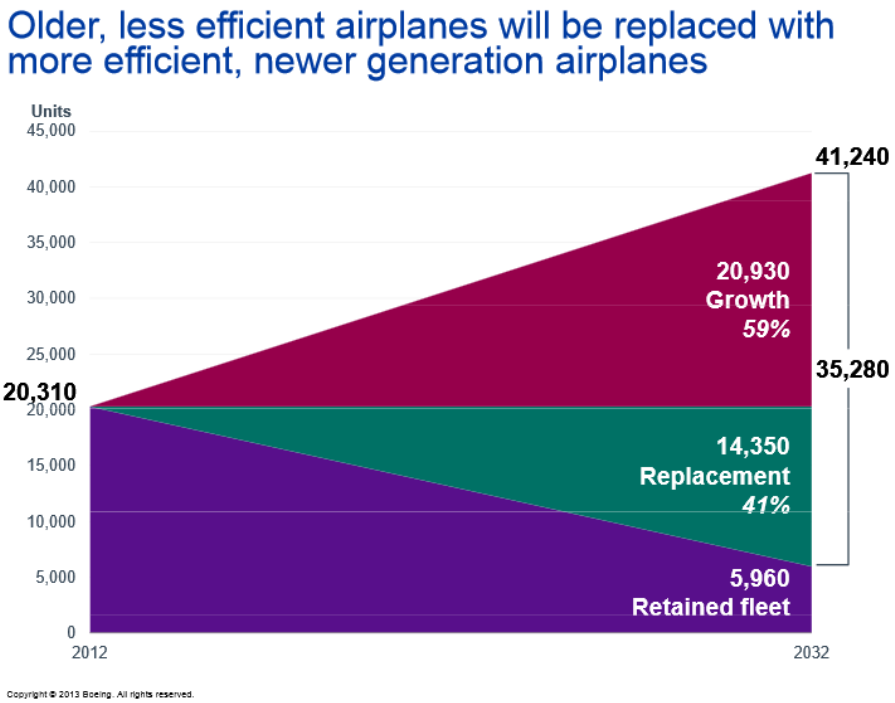

Figure 21 - Boeing's prevision for airplane sales in 2032 [28]

If we look at the 2012 global aircraft fleet which corresponds to a total number of 20,310 units we see that by 2032 about 70% (14,350 units) of the planes currently flying will be replaced by brand new ones. The number of planes in the sky in 2032 would also double due to the strong increase in air traffic demand.

If we put this in parallel with the way Gogo currently implements Wi-Fi on planes, we see that their main target is for the moment the retained fleet which airlines try to improve and make more attractive using optional services like in-flight Wi-Fi. Usually, brand new planes have very recent technology and very good equipment so airlines do not feel the need to develop extra services to attract their customers. With its current model, a company like Gogo may have a hard time selling its technology to the replacement fleet and the growing fleet which are both composed of brand new aircraft. For this reason, it would be extremely interesting for Gogo to partner up with a manufacturer like Boeing.

Indeed, having Wi-Fi equipment implemented directly at factory would enable Gogo Wi-Fi technology to cover the replacement and growing fleet which represent a much bigger part of the market than retained fleet. It would also enable the company to have a growth rate directly correlated with the growth of air traffic and this would be very good news for Gogo because world air travel has grown 5% per year since 1980 [28].

4.2.2. Aircraft manufacturers' point of view

Now that we have analyzed what kind of interests Gogo would have in partnering up with Boeing, let's take a look on the other side and see how Boeing could benefit from this potential partnership.

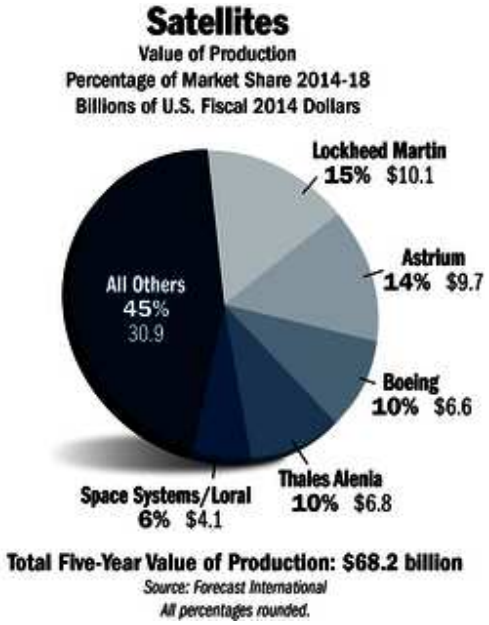

Figure 22 - Satellite ownership in the world [29]

Gogo currently offers solutions based on Inmarsat's Global Xpress Ka-band satellite service, Ku-band satellite and air-to-ground (ATG) technologies. It turns out that companies like Boeing or Airbus are not only aircraft manufacturer but they are also part of bigger entities which have space research departments. For instance, a significant part of Boeing's research is in space and satellite conception. It is the same thing for Airbus which is part of EADS, which recently changed its name to Airbus Group, and which has a whole branch named Astrium which has now become Airbus Defense & Space which also has the capacity to design, build and launch satellites.

As shown in figure 22, the number of satellites owned by Boeing and Airbus Group are quite significant. Boeing has 10% of satellites in the world and Astrium which is now Airbus Defense & Space has 14%. Therefore, partnering up with an in-flight Wi-Fi provider could be a great opportunity for aircraft manufacturers to make their satellite's fleet larger. Indeed, concerning Wi-Fi network which uses satellites, aircraft manufacturer would have the opportunity to use their own technology in complement or on top of Gogo's equipment.

In this context, aircraft manufacturers would expect to research, test and develop the hardware, software and potential services that will utilize GX Ka-band satellites, powered by

Inmarsat's Global Xpress constellation. The first Inmarsat GX Ka-band satellite, being built by Boeing was launch in 2013. Boeing also said they will initiate necessary activities to support GX Ka-band equipment installation aboard new aircraft in 2015 [30] which shows that aircraft manufacturers are highly interested in in-flight Wi-Fi technology. However, do they want to develop a technology on their own or are they willing to work with a leader on the market like for instance Gogo? Today, we cannot guess the answer for sure but it seems that Gogo is using the same type of satellites as Boeing and they may have designed very similar technologies which could merge very well with Boeing's ambitions and give birth to a fully integrated Wi-Fi system. Even if Gogo is mainly using ATG right now instead of satellites, a partnership with Boeing could be a great opportunity to strengthen the satellite branch of their business and our guess is that in terms of Wi-Fi services by satellites a lot of things will certainly change in the years to come.

4.3. Rethinking partnership with airlines

4.3.1. Understanding who the different stakeholders are

In this context of a growing market evolving very fast and involving many stakeholders (in-flight Wi-Fi providers, airlines, aircraft manufacturers, passengers, etc.) it is not easy to predict what the future trends will be. If it seems that companies like Gogo are looking for a more intimate partnership with aircraft manufacturers like Boeing then it means airlines would potentially no longer be Gogo's direct customer so one question needs to be answered: how can airline adapt their services to the next generation of in-flight Wi-Fi connectivity?

Figure 23 - All the stakeholders involved in in-flight Wi-Fi technology [31]

As shown in figure 23, there are three main layers involving in-flight Wi-Fi providers, airlines' services and aircraft manufacturer, each of them playing an important role in in-flight Wi-Fi business:

- **Open hosting platform configuration**: this first layer includes computing hardware and communication hardware. Right now in-flight Wi-Fi providers like Gogo are responsible for this equipment but as discussed in sections 4.1 and 4.2, this could become a joint partnership with an aircraft manufacturer in order to provide a more integrated and lower cost technology.

- **Value added service layer**: this second layer is highly integrated into the aircraft operating system. It includes software integration, and encryption of data which are vital for the plane's mission but it also includes services to passengers like for instance payment gateway or videos streaming. Some of the services in this layer are mandatory because the plane needs them to be operated but other services are requested by airlines and provider by either aircraft manufacturers or services providers like Gogo when it comes to Wi-Fi.

- **In-flight entertainment services**: this third layers includes any type of content that is available for passengers. It could be in-flight entertainment like movies, games, apps, etc. This content is usually commissioned and managed by the airline itself but it does not belong to it. Airlines do not own the operating license for instance for movies or games. They use companies specialized in in-flight entertainment instead and when it comes to in-flight Wi-Fi, it is actually a company like Gogo which has the right to operate the content and make money out of it.

Now that we made it clear how the different players in the field of in-flight Wi-Fi connectivity interact with each other and at which level they do so, let's focus on different models that airlines could use to improve their profits and make the most out of this quickly evolving technology [32].

4.3.2. Wi-Fi package as part of a premium service

As explained earlier, because airlines do not own the operating license for the content they make available to their passengers, the only way for them to generate money is to make sure passengers pay to use in-flight entertainment. They can make them pay by increasing the price of tickets or they can make them pay on-demand. However, passengers are more and more regarding on the fares and may choose to fly another airline if the price of the ticket is lower.

In this context, a possible solution for airlines could be to include Wi-Fi in a premium service package which is available for first class or business class passengers. Indeed, the percentage of

profit airlines generate from these passengers is on average 50% which is very significant. This category of passenger is ready to spend more for additional or better services so having in-flight Wi-Fi in a premium package could be a good strategy. Going back to figure 23, this would mean changing the value added service layer to offer better services to premium passengers. As we saw earlier companies like Gogo and like Boeing are already strong actors on this layer and if airlines want to develop this strategy they will have to do it in agreement with both in-flight Wi-Fi providers and aircraft manufacturers.

4.3.3. Making profit with Wi-Fi enabled content

Another strategy airlines could implement without involving aircraft manufacturers in the process is to make profits directly with Wi-Fi enabled content and not with fares from Wi-Fi access. In other words, a good idea could be to democratize Wi-Fi and make it available for all passengers for free with no ticket price increase. To make up for the lack of revenue, airlines could display ads any time a passenger would go to a different website or would use an app. This would mainly impact the third layer on figure 23 and may be an easier change in strategy to implement because it only requires finding commercial partners willing to display their ads and if you have already flown you know airlines already have strong relations and contacts in the domain of advertising campaigns. We will see in the future which option airlines develop. In-flight Wi-Fi is still a new concept and airlines will have to try different business models before finding the one that maximizes their profit.

However, there are non negligible chances that the best business model for airlines would not be the best one for in-flight Wi-Fi providers so for this reason it is very important when analyzing this technology to understand how the stakeholders interact with each other and where they interest lays.

5. Lessons learnt from this case study

In terms of technology, it appears that Gogo's strategy to introduce 2Ku and GTO solutions is a good move. Since satellite-based solutions offer higher bandwidth and bigger coverage, thus improved satellite technology may enable Gogo to enter transoceanic routes and make partnerships with international airlines.

In order to better understand customers' expectations concerning in-flight Wi-Fi service, we have conducted a research based on survey results. The distribution of the 30 MS&E 238 students according to age (Figure 24) is biased toward people aged 20-29.

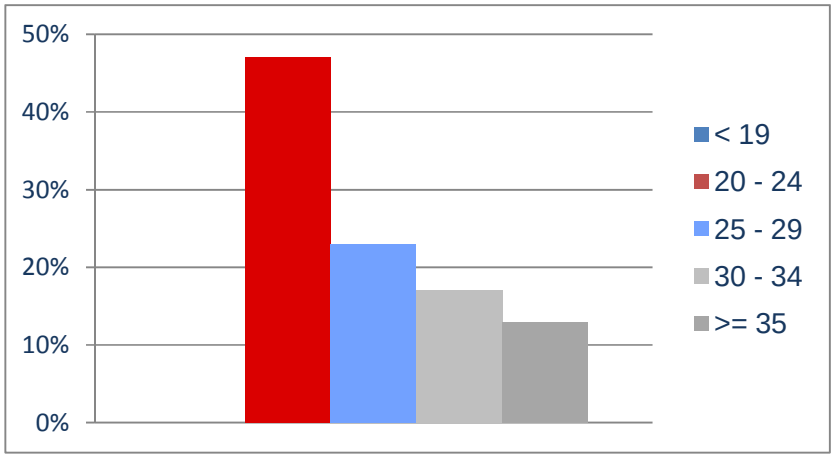

Figure 24 - Age distribution of survey respondents

The data shows that 57% usually use Wi-Fi in public transportation. Moreover, 70% of respondents have flown in an aircraft with in-flight Wi-Fi. What is interesting, only 34% of respondents have paid for the Wi-Fi. The ratio (33%) is approximately the same for people who are willing to pay more for a plane ticket with in-flight Wi-Fi pass. Unsurprisingly, as we live in the era of social media, 68% of the respondents used Wi-Fi for personal purposes. However, only 40% were satisfied with the quality of the connection.

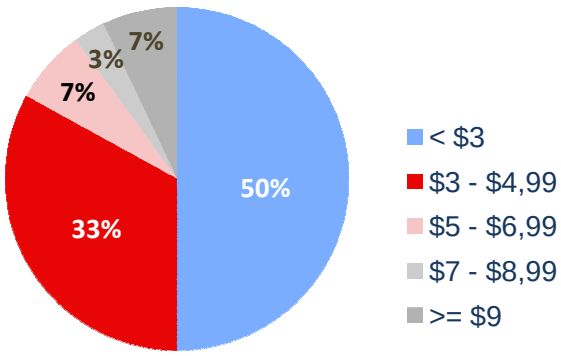

Figure 25 - Max acceptable price for 1 hour of in-flight Wi-Fi

Furthermore, as shown in figure 25, 83% of respondents are willing to pay less than $5 for 1 hour of in-flight Wi-Fi. Taking into consideration the fact, that Gogo offers 1 hour of in-flight Wi-Fi at a price $5 per hour, hence the price is too high for most of respondents. However, the majority (97%) is willing to use free Wi-Fi with advertising content.

As we demonstrated in this paper it is really likely that given Gogo's technology and business model today, they will operate some change in the years to come concerning their marketing strategy in order to remain leaders on the market. Since 97% of our respondents were in favor of free in-flight Wi-Fi with advertising we may be tempted to think that Gogo, following this trend, would prefer to strengthen partnership with airlines which manage Wi-Fi content than with aircraft manufacturer. We will see what happens in the years to come. Who knows? Gogo may come with an even more surprising strategy that no one expects…

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