



***North American Telecommunications
Equipment Repair Market***

Forecast & Vendor Analysis

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Introduction

Telecommunications Third-Party Support

The third-party telecommunications and networking equipment repair after market is for service providers that operate networking products that are no longer supported or repaired by the original equipment manufacturer (OEM). It may be that the OEM no longer supports their legacy products, that their support contracts are too costly, or the operator prefers repair services from a third-party that can support products from multiple OEMs. When a product is initially sold it comes with a standard warranty. The warranty typically lasts for one year and then the service provider often purchases an extended service and support contract from the OEM, which will extend product and repair support for five-to-seven years after the date of purchase.

OEM versus Third-Party Support

After five-to-seven years, infrastructure products are often fully depreciated and sometimes out of warranty and support from the original telecom infrastructure vendor or OEM. At this point, service providers are either left on their own to support and repair the equipment or they frequently turn to another set of vendors that specialize in support and repair of legacy telecommunications and networking equipment. Third-party repair service providers play a critical role in assisting network operators manage and maintain legacy networks well beyond their typical 5- to 10-year product life-cycles. Increasingly, repair and return services offered by OEMs are too expensive for operators and they are thus increasingly choosing third-party repair services for current-generation products.

Service providers often find it more economical to repair their legacy telecom infrastructure in lieu of expensive ‘overbuilding’ and architectural upgrades. Often times the services that this telecom infrastructure supports (e.g., wireline voice or POTS) are regulated and declining, but still highly profitable.

Telecom infrastructure vendors are often driven by market capitalization, which emphasizes top line growth. Thus, vendors tend to invest in and promote those technology and product lines that will drive the top line. As a result, OEMs are often quick to end-of-life legacy products in favor of those newer products that promise greater top line growth. Expanding revenues also help to justify increases in spending in research on new products. Without revenue growth, there is pressure to reduce spending at all levels.

As network equipment ages, so does the workforce of engineers, service and support personnel and technicians that support the equipment. As this segment of the workforce retires, third-party repair firms consolidate this technical expertise thereby providing a valuable service to the industry. Universities focus their education and training on the current state-of-the-art and leading-edge products and technologies. These new graduates would not have training or experience in legacy systems.

Since third-party repair firms support a wide variety of OEM products, repair firms are able to aggregate this expertise and knowledge, when it no longer makes sense for an individual service provider or OEM to do so. Telecom equipment repair is an important but not very well publicized element of the telecom and networking equipment ecosystem that provides a key service to operators as they manage their networks over decades.

Network Transformation Drives Consolidation

Legacy, purpose-built networking and time division multiplexing (TDM) voice products are being phased-out of networks in favor of software-based products that operate within software defined, virtual or cloud-based networks. In other words, traditional network elements are being programmed into code based on opensource software, to run in a datacenter comprised of common, off-the-shelf (COTS) network servers, networking, and storage components.

As the number of wired connections decrease, the number and capacity of central offices is reduced. Central office consolidation allows for older equipment to get into the market to help fortify the stocks of legacy parts. The result of this consolidation and the ever-increasing demands for bandwidth across wired and wireless services means that carrier backbones must continually be upgraded with new equipment

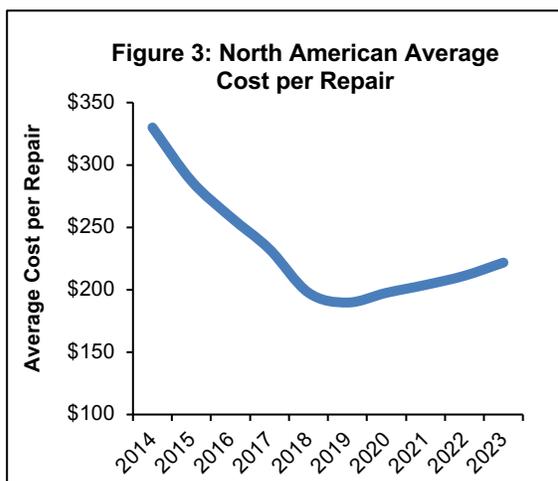
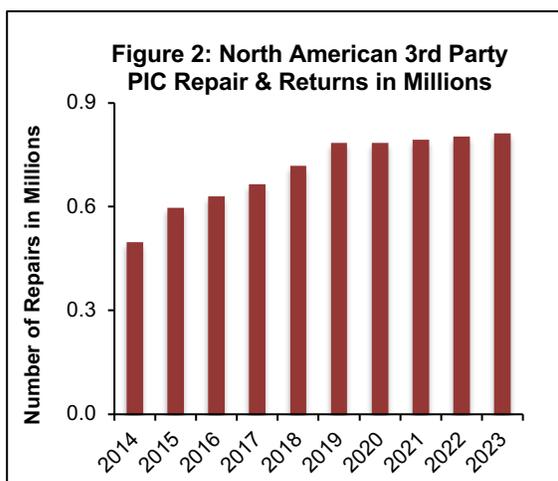
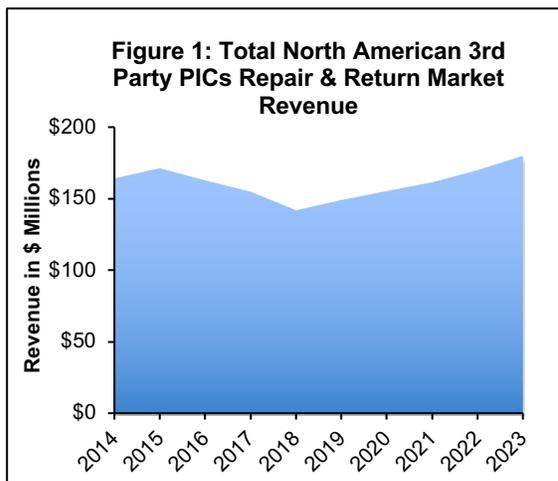
With products and networks shifting away from traditional purpose-build products to software-based products, those vendors that specialized in physical purpose build products have been slow to transition their revenues away from the legacy products and architectures to the new software- and cloud-based systems. As a result, many of these vendors have merged in order to find growth, capture some economies of scale, and improve their market power (influence over prices) given the diminished competition.

Evolving Telecommunications Business Models

While telecom OEMs have been under pressure to show growth and improve profitability, so have their customers, the service providers and network operators, who have lost much of their services-based revenue (revenue from voice and messaging) and profits to the web-scale, over-the-top (OTT) service providers, namely: Apple, Facebook, Google, Netflix, Microsoft and Amazon. Service provider increasing rely on connection and bandwidth-based revenues which are often commoditized and very price competitive. Competition with OTT has forces network operators to merge themselves and to acquire content. They are also in the process of recasting their networks and services to more resemble those of OTTs. Telco's have traditionally relied on monthly ARPU-based revenue models. ARPUs are under constant pressure from the OTTs who often offer similar services for free (or close to free) and supported by advertising. Service providers are also investing in enterprise and vertical market applications based on Internet-of-Things (IoT) like mobile-health, manufacturing, and transportation and logistics where they can leverage the quality and the tight control they have over their networks and services.

Network operators are also increasingly divesting themselves of legacy networks and services, reducing headcount supporting those legacy services, and reducing spending on expensive, OEM-based service and support programs in favor of outsourced service and support programs. In October 2018, Verizon announced that it would be offering severance packages to approximately 44,000 IT and operations staff—approximately one-third of its workforce—as it transitions those functions to Infosys of India. This trend has been benefitting third-party repair firms as well and gives those firms more opportunity to expand into other third-party services like customer technical assistance center service (CTAC), logistics, and software support. From more than 235,000 employees in 2007, Verizon is expected to have approximately 110,000 after the full effect of the Infosys outsourcing.

Another example is that of Sprint's 2009 outsourcing deal with Ericsson that expired in 2016. The seven-year agreement transferred 6,000 Sprint employees to Ericsson in 2009. As the deal expired in 2016 and with Ericsson, a key OEM for many North American network operators, trying to divest itself of these outsourcing agreements, it leaves good opportunity for third-party telecom services companies to fill-in as Sprint relies less on OEM-based support programs.



Forecast Results

Third-Party Repair & Return Market Forecast

In 2018, we expect that the North American market for third-party telecommunication equipment plug-in card (PICs) repair will be \$142 million. In 2015 the North American market for telecommunication equipment repair services was \$180 million and we forecast that the market will grow by an average of 5 percent per year through 2023 to reach \$180 million (Figure 1). Telecom equipment repair services are just one segment in a total market for secondary telecommunications services that is \$5 billion dollars per year. In addition to telecommunications equipment repair services, the total third-party telecom services market includes: logistics and spares management, sales or re-sale of equipment, technical phone support or customer technical assistance center (CTAC), and repairs of set-top box and other CPE equipment.

Number of Equipment Repairs Steady

In 2014 there were approximately 600 thousand individual telecom PIC equipment repairs. We expect that in 2018 there will be nearly 700 thousand repairs and that this will grow by an average of 2% per year through 2023 to over 800 thousand repairs (Figure 2).

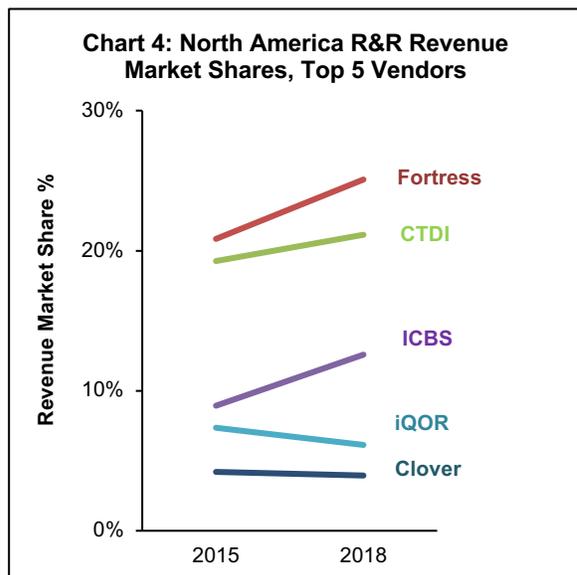
Price Pressures Ease

In 2018, we believe that the average price per PIC repair was \$198, down nearly one-third from the level in 2014. The average revenue per repair in 2014 was \$330. The repair prices can vary significantly based on the type of equipment being repaired. Enterprise-class equipment, like fixed configuration switches are typically repaired for less than \$100 per unit while a high-end optical line card might be repaired for approximately \$1,400 per unit. Despite this recent price pressure, we forecast that through 2023, the average price per repair will increase by an average of 2% per year. This increase will be driven by three main factors: (1) somewhat less competition due to consolidation, (2) scarcity in the parts and skills needed to repair legacy equipment, and (3) a shift in mix toward more expensive optical transmission equipment, components, and line cards and away from legacy voice repairs (Figure 3).

Vendor Consolidation

Just as there has been consolidation amongst the large network operators, there has been considerable consolidation amongst the original equipment manufacturers (OEMs) and the equipment repair market has also seen consolidation. Generally speaking, consolidation occurs when growth begins to slow, and companies find that they will benefit from economies of scale in terms of their cost and distribution networks and that they can begin to capture more control over the pricing environment. Currently, larger national and regional operators are looking to use a smaller number of larger telecom firms as their primary source of repairs, leaving smaller firms to subcontract to the larger firms, explore new or adjacent markets, and/or to focus on smaller opportunities.

The telecom equipment repair market is no exception and has become more concentrated in recent years. In 2018, the top 5 vendors accounted for nearly 70% of the repair market revenues in 2018, up from 61% in 2015. A more detailed discussion of the vendor dynamics is included below.



Vendor Dynamics

Fortress Solutions

Fortress Solutions is now the top vendor in terms of revenue and in number of repairs in the third-party repair and return market, displacing CTDI, which held the top position for many years. We estimate that in 2018, Fortress held one-quarter of the market, up from 21 percent in 2015 (Chart 4). The company's acquisition of Restor Telecom in 2014, helped to drive this gain in share. Fortress recently introduced its FortressOne program, a program whereby operators can "subscribe" to a bundle of services, including repair, CTAC, and sparing/logistics for a specific number of repairs per year. The program gives operators a consistent budget item despite perhaps having volatile short-term demand for repair services. Fortress is investing to expand into the adjacent

CTAC and logistics markets, which should prove to be fertile markets given the structural and economic changes happening in the telecommunications sector.

CTDI

CTDI, which is headquartered outside of Philadelphia, dominates the US telecom equipment repair market. We estimate that CTDI has perhaps two-thirds of the telecom equipment repair market in terms of revenue. When it comes to specific PIC repair, CTDI has perhaps one-fifth of the market, making it the runner-up to Fortress. CTDI has been in business for over 40 years and was able to gain significant size in the late 1990's and early 2000's when the first Internet bubble burst. During this time CTDI was able to acquire repair facilities and customer relationships from Nortel and other firms. As the telecom equipment repair market has become more competitive, CTDI has looked to diversify into CPE like set-top boxes, and more recently into automotive electronics remanufacturing.

ICBS

Inter-Commercial Business Systems or ICBS, has been in business since 1989 and is located in the Dallas area. We estimate that their share of the North American PIC repair market is 12 percent in 2018, up three percentage points compared to 2015. We believe that ICBS's primary business is with CenturyLink and that is also has many other, smaller customers which helps to keep ICBS's repair revenues steady.

IQor (Telmar)

We believe that Telmar Network Technology, which is now part of IQor Corporation, in 2018 has 6 percent of the PIC repair market, down slightly from 2015. The company has a long history in the repair business. In August 2011, Jabil, a multi-billion dollar contract-manufacturing firm, acquired Telmar for their aftermarket services group. In December 2013, Jabil sold its aftermarket services group to IQor Corporation. We believe that the old Telmar business, which focused on repair and logistics services for networking and telecommunications equipment, has shrunk considerably in the wake of the acquisitions and divestments.

Clover Telecom

Clover Telecom (formerly American Communications) was founded in 2001 and is headquartered outside of Dallas, TX. We believe that the bulk of their business is in the repair-and-resell market with the repair-and-return being secondary. We estimate that the company holds nearly 5 percent of the repair-and-return market in 2018, up a percentage point compared to 2015.

Other Vendors

Beyond these vendors, the market becomes increasingly fragmented with many firms having annual repair revenues in the \$6-7 million range for PIC repairs. These vendors have limited scope and expertise in their ability to repair a wide variety of equipment. As a result, the market share for the vendors outside of the top 5, declined from 40 percent in 2015 to 30 percent in 2018. Smaller firms are quite susceptible to business cycles and to changes in their customer base which tends to be concentrated amongst several large accounts and are often focused on the much older voice technologies. The structure speaks toward further consolidation, which is discussed below. The presence of so many small repair firms increases the price pressures, perhaps to unhealthy or minimally profitable levels whereby it becomes difficult to sustain the business in the long term as costs of doing business continue to rise. Larger firms can better exploit economies of scale, providing scale large enough to repair a wider variety of SKUs, and providing some price protection via diminished competition.

VI. Methodology

Surveys and interview requests were sent to 20 of the largest North American telecommunications repair firms. A partial list of the companies considered for this study, in no particular order, is below:

CTDI	Fortress Solutions
MP Instrument Company	ICBS
iQOR (formerly Telmar)	Precision Electronic Repair Services
Telecom Test & Repair	XTech Gear
101 Telco	S&R Resources
Singlesource	Tempest Telecom
Clover Telecom	Maverick Technologies, Inc.
Tescom	Worldwide Supply, LLC

Companies were asked about their levels of business, employment levels, number of repairs and repairs of specific plug-in cards, and trends in the business and in the industry over time.

Based on this information, a financial model for the telecommunications equipment repair market was created and the size of the actual market in terms of revenues, number of repairs, and headcount for 2018 was formulated. The forecast is based off of qualitative discussions conducted as part of the interview process and factoring in overall trends in the telecommunications equipment and related markets, plus analyst judgment.

VII. About Exact Ventures

Exact Ventures is an independent market intelligence firm that creates unbiased, enduring benchmarks for measuring market shares and understanding and quantifying market transitions and market opportunities within its coverage areas.

Exact Ventures offers market intelligence with greater depth and context than traditional, static silos of market data. Exact Ventures' research combines both supply- and demand-side market intelligence and highlights the economics underlying emerging and transitioning markets and technologies.

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Table 1: North America Communications Equipment Plug-in Card (PIC) Third-Party Repair & Return Market

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2018-23 CAGR
Revenue in \$ Millions											
Total	\$164.2	\$171.4	\$162.8	\$154.7	\$142.0	\$149.0	\$155.2	\$161.7	\$169.8	\$179.9	5%
Number of Repairs in Thousands											
Total	497	597	630	665	718	785	785	793	804	811	2%
Average Selling Price per Repair in \$											
Total	\$330.00	\$287.10	\$258.39	\$232.55	\$197.67	\$189.76	\$197.54	\$203.86	\$211.20	\$221.76	2%
Sequential Change in Revenue %											
Total		4.4%	-5.0%	-5.0%	-8.2%	5.0%	4.1%	4.2%	5.0%	6.0%	
Sequential Change in Repairs Shipments %											
Total		20.0%	5.6%	5.6%	8.0%	9.4%	0.0%	1.0%	1.4%	1.0%	
Sequential Change in Average Selling Price per Repair %											
Total		-13.0%	-10.0%	-10.0%	-15.0%	-4.0%	4.1%	3.2%	3.6%	5.0%	
Headcount and Productivity Metrics											
Total Repair Headcount	5,200	5,000	4,850	4,500	4,350	4,100	3,895	3,700	3,515	3,339	-5%
Revenue per Headcount	\$31,569	\$34,272	\$33,565	\$34,367	\$32,632	\$36,353	\$39,835	\$43,693	\$48,292	\$53,884	11%
Repairs per Headcount	95.7	119.4	129.9	147.8	165.1	191.6	201.7	214.3	228.7	243.0	8%

Table 2: North America Communications Equipment Plug-in Card (PIC) Third-Party Repair & Return Market

Company	Revenue in \$ Millions		Revenue Market Share %		Average Annual Revenue Growth
	2015	2018	2015	2018	
Fortress Solutions	\$35.7	\$35.6	20.8%	25.1%	-0.1%
CTDI	\$33.0	\$30.0	19.3%	21.1%	-3.1%
ICBS	\$15.3	\$17.9	8.9%	12.6%	5.3%
iQOR (Telmar)	\$12.6	\$8.7	7.4%	6.1%	-11.6%
Clover Telecom	\$6.0	\$6.6	3.5%	4.6%	3.2%
Renaissance Repair (Canada)	\$7.2	\$5.6	4.2%	3.9%	-8.0%
Precision Repair	\$6.0	\$4.0	3.5%	2.8%	-12.6%
Xtech Gear	\$3.0	\$3.0	1.8%	2.1%	-0.3%
Telecom Test & Repair	\$6.0	\$2.8	3.5%	2.0%	-22.4%
S&R Repair	\$7.2	\$2.7	4.2%	1.9%	-27.9%
Tempest	\$7.8	\$2.5	4.5%	1.8%	-31.4%
Maverick Technologies	\$3.6	\$1.0	2.1%	0.7%	-34.8%
Singlesource	\$3.2	\$1.0	1.9%	0.7%	-32.1%
101 Telco	\$1.8	\$0.6	1.1%	0.4%	-29.5%
Other Companies	\$23.0	\$20.0	13.4%	14.1%	-4.6%
Total	\$171.4	\$142.0	100.0%	100.0%	-6.1%