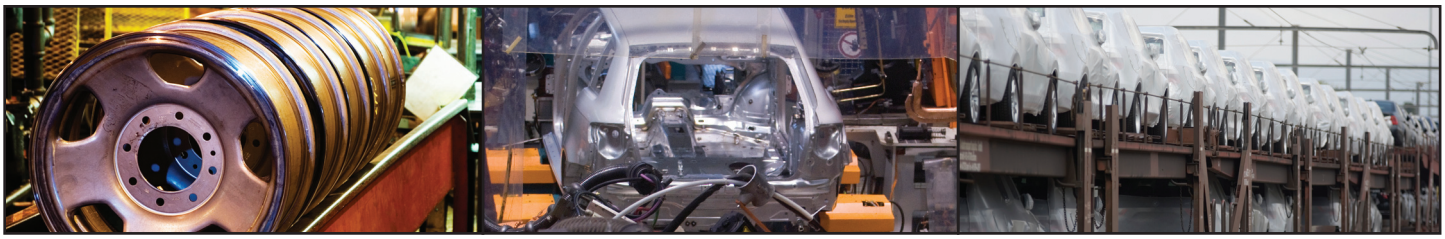

General Motors Prepares for Future with Next-Generation Information Networks for Global Manufacturing Operations; On Track to Achieve 166% ROI Over Five Years

HIGHLIGHTS

CUSTOMER PROFILE

- **Region:** North America
- **Industry:** Automobile Manufacturing
- **Employees:** 235,000 worldwide
- **Business Issue:** Plant-floor IT network optimization

BACKGROUND

- One of the world's largest automakers
- Operates in 140 countries; its largest markets are the U.S., China, Brazil, the UK, Canada, Russia and Germany
- Brands include Buick, Cadillac, Chevrolet, GMC, GM Daewoo, Holden, Opel, Vauxhall and Wuling

GOAL

Accelerate entry into emerging markets, improve product quality and realize cost efficiencies by creating a globally integrated, standards-based engineering and manufacturing platform

SOLUTION

GM's Plant Floor Controls Network (PFCN) Solution, including:

- CiscoWorks Network Management Suite
- Cisco Unified Collaborations Server
- Catalyst 6500
- Catalyst 3750
- Catalyst 2955
- Catalyst 2960

RESULTS

- Projected 166% ROI over 5 years
- Gained $75M in lost unit profit contribution
- Reduced network downtime by 75%
- Gained more than $21M in design engineering staff savings
- Gained more than $53M in network operations staff savings
- Gained $5M in inventory carrying cost savings

Executive Summary

One of the world's iconic automakers, General Motors continues to be a force to be reckoned with in the global auto industry. The company has sharpened its strategic focus in recent years and is now moving aggressively to seize high-growth opportunities in emerging markets such as Asia, and redoubling efforts to improve product quality and boost operating efficiencies to drive down costs.

To execute this strategy, GM embraced a globally unified business model that emphasized the deployment of highly standardized engineering and manufacturing platforms that could be easily implemented and supported in any market around the world. The global, standards-based operating model would accelerate GM's move into emerging markets and generate efficiencies and cost savings through the use of common infrastructure components and processes.

Among other initiatives designed to support the new unified operating model, GM invested in information technologies to more tightly integrate its manufacturing plants across the globe, control costs, and accelerate the introduction of new communications and collaboration applications. Key to this strategy was the implementation of a modern, standards-based network architecture – called the Plant Floor Controls Network (PFCN) – at more than 150 GM manufacturing plants worldwide.

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Based on a single set of Cisco-based network designs and equipment, the PFCN solution replaced GM's aging and heavily customized legacy networks that were becoming increasingly unreliable, as well as difficult and expensive to maintain. The move to the PFCN solution enabled GM to standardize the design of each plant network and establish a single engineering team that monitors and troubleshoots network operations globally. The result: network downtime has dropped by about 70%, leading to fewer unplanned work stoppages on the plant floor. Furthermore, GM now needs two-thirds fewer network engineers and analysts to support the same number of plants.

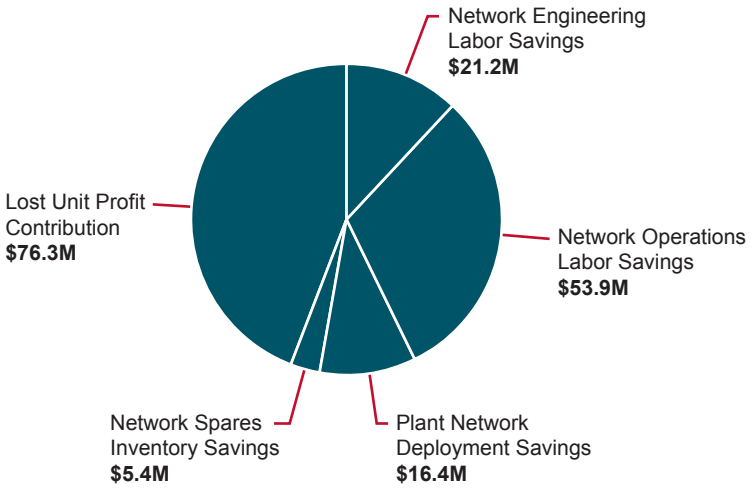
The standardized Cisco network design also helped GM rationalize and reduce its legacy inventory of network devices and spare parts, cutting inventory carrying costs by 70%. It also allowed GM to create cost-efficient "global applications" that can be rolled out to plants quickly, and to automate system-management tasks like upgrades and patches. As a result, GM now spends 30% less time managing plant software.

According to a conservative analysis by Mainstay Partners, GM's investment in the Cisco-based PFCN solution will generate a return on investment (ROI) of 166%.[1] The full range of benefits is illustrated in Figure 1 and include:

- $21.2 million in labor cost savings from more efficient deployment of network engineers
- $53.9 million in labor cost saving from more efficient deployment of network operations analysts
- $16.4 million one-time savings from faster, network setups at each plant
- $5.4 million cost reductions from leaner inventory management
- $76.3 million in lost unit profit contribution from higher network uptime

Figure 1. GM's Plant Floor Communications Network Benefit Drivers

PFCN Will Drive $173M in Benefits (5 Year Estimates)



Looking ahead, the easily replicated and managed PFCN platform is expected to help GM advance quickly into new markets, and several international joint venture partners have already adopted the PFCN solution. GM will also rely on the Cisco platform to support a range of IP-enabled technology initiatives, including enhanced plant-floor mobility applications and collaborative engineering solutions that connect front-line engineers with experts located anywhere in the world.

1 This conservative ROI figure is based on estimated net benefits of $60.5 million over five years, and excludes benefits from higher network uptime. An alternative "total cost of ownership" analysis, which factors in uptime benefits as well as full deployment costs, results in estimated net benefits of $111.8 million and an ROI of 182% over five years.

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Key Success Factors

GM credits its successful move from concept to implementation to several factors:

- **Maintain Close Relationship between Manufacturing Operations and IT.** As manufacturing plants continue to become more complex, networked and collaborative, it's critical to build strong relationships between the manufacturing engineers who manage the plant-floor devices and the network engineers who provide the IT systems that make them run.
- **Design for the Future.** Instead of an incremental approach, GM's IT teams designed the network to integrate new technologies to support anticipated growth for years to come, including the planned incorporation of as QoS, security, and multimedia applications.
- **Prove the Capabilities of PFCN in Stages.** Manufacturing executives tend to be conservative and skeptical in nature, so GM first performed exhaustive engineering and testing on the network design before piloting the PFCN design in two plants. The pilots demonstrated that the team could not only deploy a new network to a plant in less than two months at a low, well-defined cost, but also deploy the PFCN solution in parallel to scale the solution globally.
- **Choose the Right Partners.** With network engineering expertise from Cisco and its partners, GM was able to define a standard template with guidelines for plants around the world. Cisco and its partners' engineers were also an integral part of the overall support model as well, providing tier-3 level engineering support when advanced networking expertise was required.

The Opportunity

Despite current economic challenges, GM has set its sights squarely on the future with a master plan called "One Company" – a unifying strategy that aims to better integrate GM's engineering, manufacturing and sales operations worldwide. The goal is to create a highly efficient and flexible business platform that will allow GM to "design globally", "manufacture anywhere", and "sell everywhere".

A key component of this strategy has been a multi-year initiative designed to modernize and standardize the information networks that support GM's global manufacturing plants. These complex networks are essential to keeping GM's plants running smoothly: they control the automated machines and programmable devices on the factory floor as well as the communications infrastructure that allows managers to oversee production and collaborate with engineers and partners worldwide.

GM stood to gain significant benefits by upgrading its legacy networks. Based on outdated technology and aging equipment, the old environment posed growing operational challenges for GM's factories. Network outages were occurring more frequently, often leading to plant downtime and higher per-unit costs. The legacy networks also lacked the technology needed to run the next generation of plant-floor automation equipment that features IP-based "intelligent network" and quality of service (QoS) capabilities. Other opportunities for improving efficiencies, such as applications that allow engineers to collaborate remotely, would require the same advanced networking infrastructure.

GM also saw the potential for cutting costs through standardization. GM's old networks were built with a variety of proprietary and plant-specific designs, so each factory had its own customized architecture along with a unique set of equipment requirements and bills of materials (BOMs). Managing these diverse networks required the support of a larger-than-necessary staff of design engineers and operating personnel. Economies of scale were hard to achieve because the engineering expertise at one plant couldn't easily be leveraged to support other facilities. The lack of network standards also forced plants to stock a wider assortment of backup gear, which kept inventory costs high

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The Solution: GM's Cisco-based Plant Floor Controls Network (PFCN)

Seeking to capitalize on opportunities for driving down costs and improving service levels, GM developed plans for a comprehensive overhaul of IT networks at its manufacturing facilities around the world. The new platform – called the Plant Floor Communications Network (PFCN) – would implement a single set of network-design standards worldwide and use the latest networking technologies and equipment from Cisco Systems[2]. To date, the PFCN solution has been implemented at more than 150 GM plants across all its major markets.

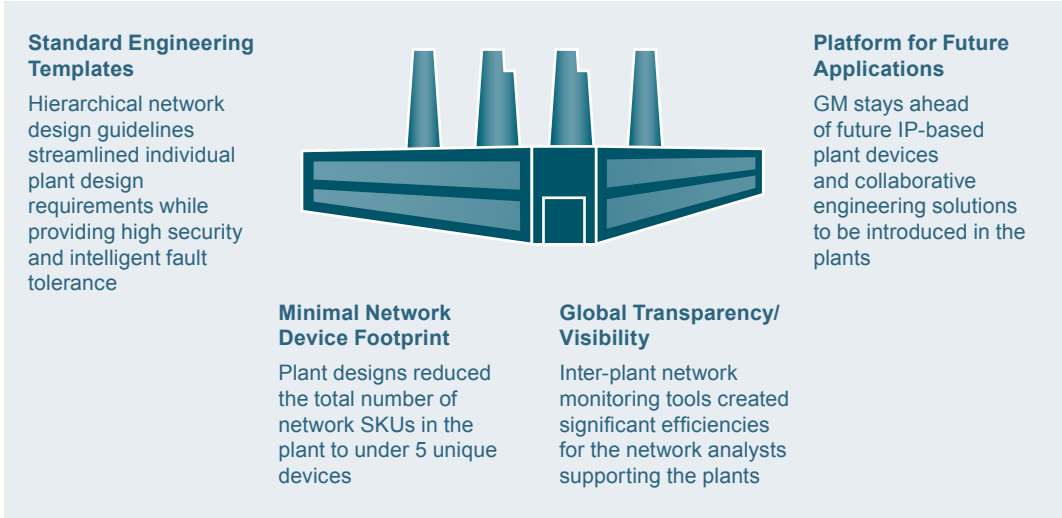
By establishing a standard network template that can be replicated at every plant around the world, the PFCN solution allowed engineers to design and build networks more quickly than before. Since the basic designs are the same in every plant, network analysts can monitor and troubleshoot networks at virtually any location. Inter-plant monitoring tools were built into the PFCN platform to facilitate remote visibility into dozens of plants from a central facility. The move enabled GM to both save money and speed fixes by consolidating engineering services in each region.

The standardized PFCN solution was designed to minimize the network-device footprint at each plant and reduce the total number of parts or stock-keeping units (SKUs) held in inventory. Today, only five standard devices are deployed at each plant, which means GM can stock fewer backup devices and parts overall and hold more inventory in cost-effective regional warehouses.

Although it enforces a standard logical network architecture – or VLAN – for each plant, the PFCN solution allows engineers to implement a variety of local physical setups to ensure optimal network performance at a particular plant. The solution includes guidelines that help engineers design both large and small-scale versions of the network. Because it employs intelligent networking capabilities from Cisco, the PFCN solution provides a significantly more reliable and fault-tolerant platform compared to GM's legacy environment.

As detailed below, network downtime has been reduced dramatically, contributing to reductions in GM's per-unit manufacturing costs. Furthermore, the new IP-based networks will enable GM to keep pace with new advances in plant-floor devices such as programmable logic controllers (PLCs), which increasingly incorporate IP technology. In addition, PFCN will help GM integrate future communication applications that facilitate high-efficiency collaboration among its workforce while minimizing the risks associated with these deployments.

Figure 2. GM's Plant Floor Communications Network Solution



2 Contributing Cisco products listed in the Executive Summary on page 1.

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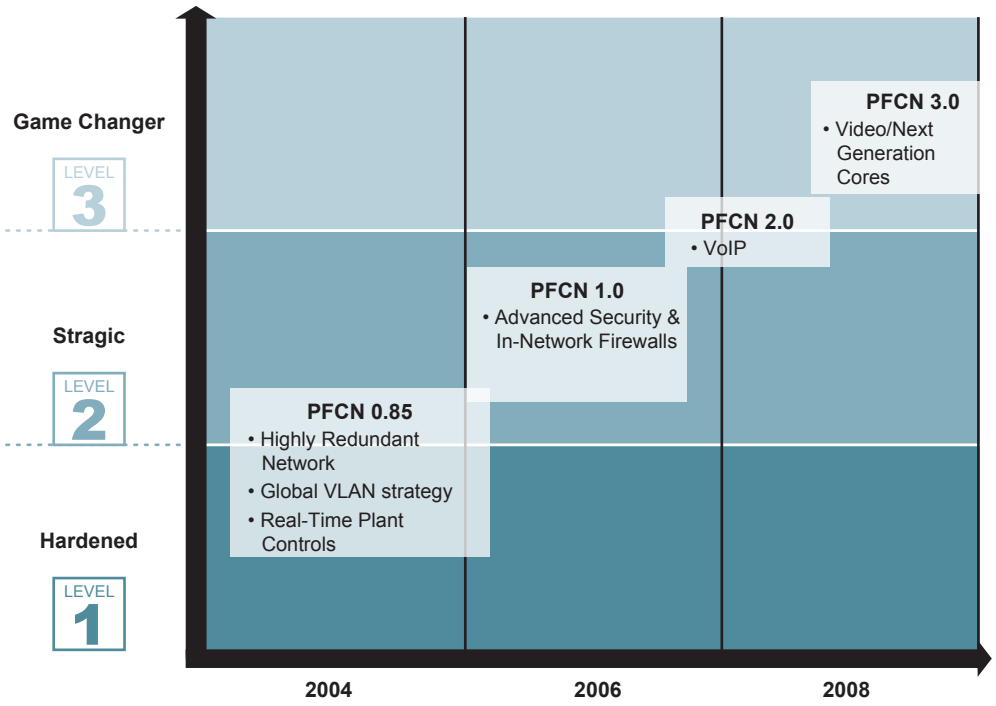
> **"PFCN is a tremendous engineering accomplishment for GM. Standardizing plant networks has reduced costs, improved uptime and provided a flexible platform for future applications such as collaborative engineering"**
>
> **—Nick Bell, Program Information Officer, Global Manufacturing & Labor**

Today, about 90% of GM's plants – encompassing 220 million square feet of floor space – are running on new PFCN networks, which were deployed over a 32-month period. GM management made the decision to deploy PFCN after becoming convinced of the serious risks posed by delaying upgrades to aging network equipment, and after reviewing a business case that calculated significant benefits from a move to PFCN, including increased plant uptime and lower total ownership costs.

Before green-lighting a global implementation, however, GM piloted the platform at one plant in each region. The success of these pilots secured final buy-in from senior executives, and GM moved forward with a phased implementation starting in 2004, as detailed in Figure 3.

Figure 3. PFCN Implementation Timeline (2004 – Today)



PFCN 0.85	PFCN 1.0	PFCN 2.0	PFCN 3.0
Focused on developing an highly redundant, global VLAN capability with real-time network performance to the Programmable Logic Controllers (PLCs) devices on the manufacturing floor.	Enhanced network security through both market leading technologies and a global software patch/ replace program that accelerated time-to-production and minimized risks of downtime.	Through Cisco's integrated suite of VoIP, QoS and Layer-3 networking equipment, GM is deploying VoIP to the plant floor to enhance collaboration.	Future of plant floor operations will include video linkage from the floor to engineering and suppliers.

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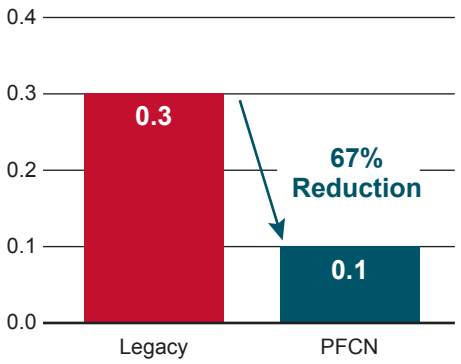
The engineering and operational standardization built into the PFCN platform served to lower the risk – and costs – associated with large-scale technology deployments. The standard platform will also help GM accelerate the future rollout of network enhancements and new technologies, such as mobile applications and collaborative engineering platforms, that will boost productivity further — all at a lower marginal cost and reduced risk.

$53M in Labor Productivity Benefits

According to an analysis by Mainstay Partners, GM is on track to realize more than $21 million over five years in network engineering labor savings from its PFCN investment. The savings reflect a two-thirds reduction in the number of level-3 design engineers GM needs to support its global PFCN platform, as shown in Figure 4. Drawing on a single set of design templates, engineers working in the PFCN environment can create the logical design of a plant network in one day, compared to three-to-four weeks previously. During the initial design phase of the global PFCN network, these efficiencies generated one-time savings of approximately $100,000 per plant.

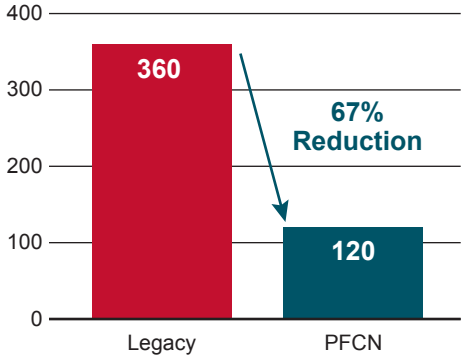
PFCN allowed GM to set up a single, global engineering team that monitors networks around the world in a “follow the sun” operation. Level-3 design engineers can support a plant anywhere in the world because all the networks share the same logical architecture.

Figure 4. Number of Network Design Engineers per Plant



In addition to the design-engineering savings, GM is expected to save more than $53 million (over five years) by streamlining the day-to-day operation and maintenance of the networks. Again, PFCN’s standardized networking environment, combined with inter-network visibility, contributed to these savings, allowing GM to support its plants with one-third as many onsite network operations staff, as shown in Figure 5. Today, on average, large plants can be serviced by just two network analysts and smaller plants by one analyst. (In some cases, a single analyst can service more than one small plant.)

Figure 5: Number of Global Network Analysts



$76M in Increased Profit Contribution from Improved Manufacturing Uptime

With its built-in redundancies, high-availability and management features, the PFCN design ensured that the network would no longer be the leading cause of plant downtime. (In the past, network outages were responsible for 70% of unplanned IT production stoppages.) The system’s monitoring tools, for example, minimize network outages by helping engineers detect and address issues before they become critical. Since implementing the Cisco platform, GM has seen a 75% drop in network outages – from about 11,000 minutes to 2,500 minutes per year – and current factory network uptime is now running at 99.99989%. Better uptime performance is helping GM improve operating

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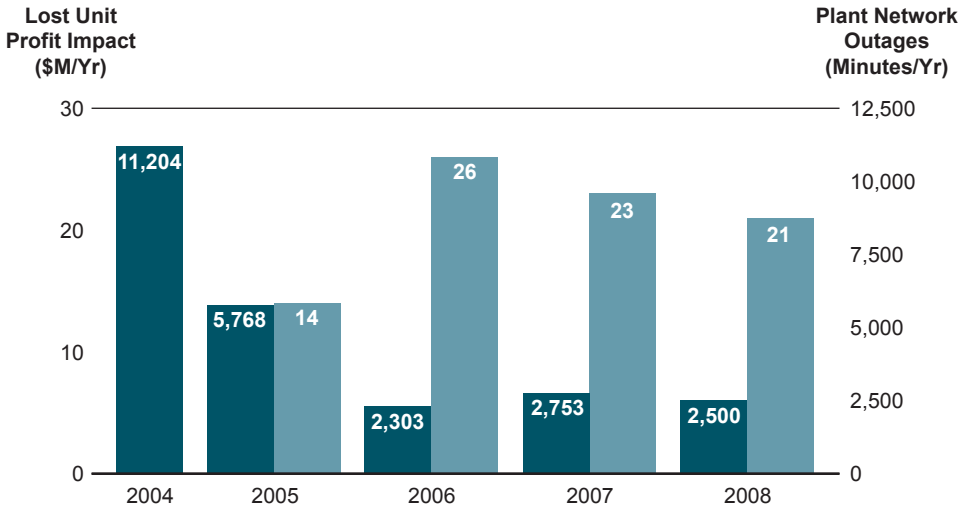
margins by reducing the per-unit costs incurred when its manufacturing lines experience unplanned downtime. Mainstay estimated that higher network uptime will help GM generate $76 million in lost unit profit contribution over five years. Figure 6 shows the reduction in network outages and the associated dollar impact of improved uptime over that period.

Figure 6: Network Outage Improvements & Associated Lost Unit Profit Impact



$5.4M in Spare Inventory Savings

GM has generated significant savings by shrinking the size of its inventory of spare networking parts and holding a greater percentage of spares in cost-effective regional facilities instead of at local plants. The move to a leaner inventory was the direct result of PFCN's simpler, standardized design, which allowed GM to build networks with a smaller set of parts, or bill of materials (BOM), and enabled plants to hold fewer SKUs in inventory.

Better system monitoring tools also helped GM better forecast the need for replacement parts, allowing it to move key components, such as Cisco Catalyst 6500 switches, to regional distribution centers. As a result, GM can now stock 70% fewer spares overall, saving an estimated $5.4 million in inventory carrying costs over five years, as shown in Figures 7 and 8.

Figure 7: Reduction in Spares Inventory (Indexed)

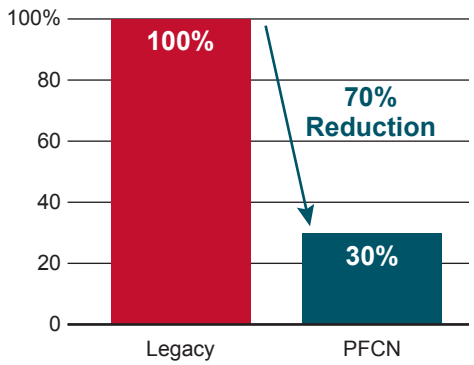
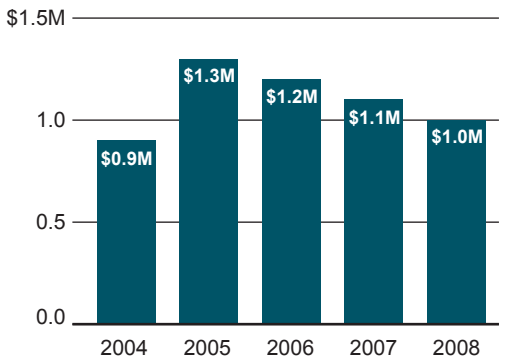


Figure 8: Reduction in Carrying Costs, 2004-08 ($M)



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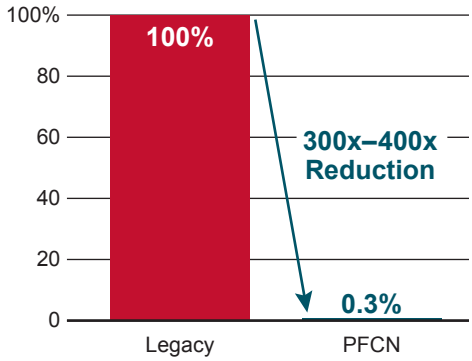
Plant Floor Application Management Efficiencies

The PFCN platform, with its reliable, standards-based network architecture, gave GM engineers the ability to build and deploy a set of global software applications that can run on any local network. Also, because engineers no longer need to research individual network configurations and customizations, GM dramatically reduced the time it takes to deploy applications to its global facilities, as shown in Figure 9. The new standard applications helped GM generate further productivity improvements by providing efficient system-management capabilities, including remote application monitoring and automated software patches and upgrades. As a result, GM estimates that it spends 30% less time managing software across its global networks.

Figure 9: Time to Deploy Applications (Indexed)



Future Opportunities

Beyond the initial operational efficiencies and cost savings gained from the PFCN solution, GM expects to leverage the Cisco-based platform to support a range of new technology initiatives and enhancements. These include:

- **Enhanced Mobility Applications.** PFCN is an ideal platform for deploying advanced mobile technologies on the plant floor, including wireless handheld devices that will connect front-line engineers with design engineering teams at a distance. Such technologies will expand the types of information that can be shared over mobile devices to include CAD drawings and other high-bandwidth content.
- **More Standards-based Applications.** GM plans to further reduce complexity and costs by replacing even more proprietary manufacturing applications with standards IP-based, "plug-and-play" solutions that are easily integrated into the PFCN architecture.
- **Collaborative Engineering Solutions.** Connecting the plant floor to the right resources to solve problems is the goal of collaborative engineering. PFCN's native connectivity capabilities – including support for VoIP and video – will make it possible for GM to bring together engineers from diverse locations and organizations, including suppliers, to rapidly troubleshoot issues and devise solutions.

Quantified Business Benefits

According to Mainstay's analysis, GM's investment in the Cisco-based PFCN solution will generate $60.5 million in net benefits over five years, and yield an ROI of 166%. The benefits include labor savings from more efficient deployment of network engineers and analysts, one-time network setup savings at each plant, and inventory carrying cost reductions. Total net benefits increase to $136.8 million if the benefits of higher network uptime ($76.3 million) are included in the analysis.[3] A summary of the incremental costs and benefits of the PFCN investment are displayed in Figure 10.[4]

Using an alternative "full deployment cost" approach, Mainstay analyzed the PFCN investment by factoring in the full costs of designing, equipping and installing the new platform – as opposed to analyzing only the incremental costs that were incurred over and above replacing the existing

3 The most conservative analysis would exclude the uptime savings, since GM could have achieved similar uptime performance by replacing the aging network devices alone rather than investing in the completely re-architected PFCN solution.

4 In this analysis, costs represent the incremental costs of designing and deploying the standardized and re-architected PFCN solution -- that is, over and above the costs of only replacing the existing networking equipment.

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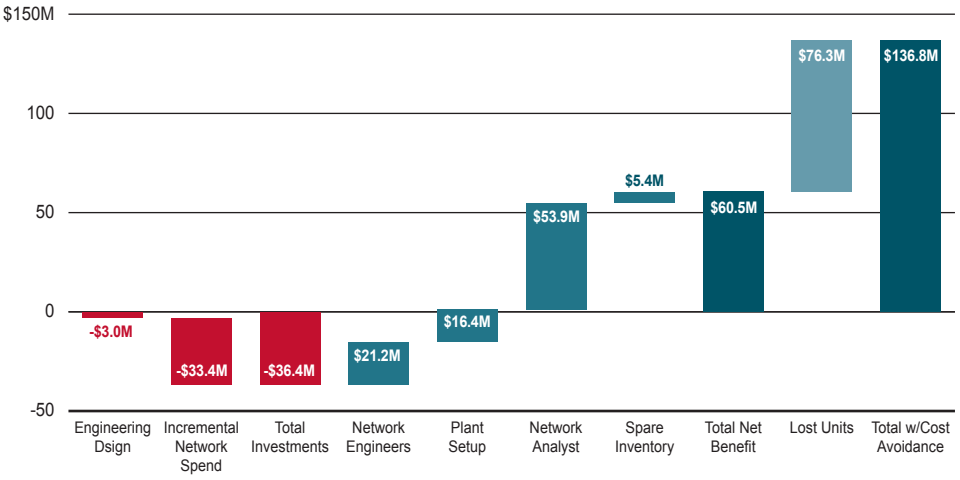
equipment. In this model, the investment costs are somewhat higher, but total net benefits increase from $60.5 million to $111.8 million due to the addition of $76.3 million in network uptime benefits. GM's ROI in this scenario is estimated at 182% with an internal return on investment (IRR) of 70%.

Figure 10. Net Present Value Analysis

Five-Year Net Present Value Analysis ($M)



About This Case Study

Research and analysis for this study was conducted by Mainstay Partners LLC, an independent consulting firm that has performed over 300 studies for leading information technology providers including Cisco, Oracle, SAP, Microsoft, Dell, Lexmark, HP, BearingPoint, EMC, NetApp, EDS and Tidal Software. This case study was based on interviews with the retailer's executives, IT executives and IT planning personnel, review of project planning documents, and searches of industry literature. ROI calculations use industry standard assumptions regarding the time value of money. Information contained in the publication has been obtained from sources considered reliable, but is not warranted by Mainstay Partners LLC.

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