MTA Storm Performance Review

June 2011

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1. Summary

1.1. December storm

A major snow storm descended upon the New York Metropolitan area on the afternoon of Sunday, December 26, 2010. The storm lasted through the night and into the morning of Monday, December 27. Snowfall and wind gusts contributed to blizzard conditions in parts of the region. Significant disruptions of transportation and other essential services were experienced across the Metropolitan area. Metropolitan Transportation Authority (MTA) operations were severely affected, necessitating curtailment or suspension of services provided by Subways, Regional Bus (Buses), the Long Island Rail Road (LIRR), Metro-North Railroad (Metro-North), and Paratransit. Other area transportation disruptions included suspension of AirTrain service to JFK, suspension of Amtrak Northeast Corridor service to Boston, closure of JFK, LaGuardia, and Newark Airports, and suspension of New Jersey Transit bus service. River crossings operated by MTA Bridges & Tunnels (B&T) remained open throughout the storm. The recovery process lasted several days, with most MTA service restored by Thursday, December 30 and fully restored operations by Sunday, January 2.

1.2. Immediate response

In the immediate wake of the December storm, the MTA Agencies conducted initial internal reviews. These focused on recounting the sequences of key operating events, identifying areas of strength, and highlighting opportunities for improvement. Near-term actions that could improve performance for the balance of Winter 2010/2011 were also outlined. A summary of the initial review findings was presented at the January 2011 MTA Board Meeting.

Some of the resulting changes that were quickly enacted included:

- Appointment of a dedicated Emergency Coordinator to facilitate MTA-wide storm response coordination and information sharing;

- All-Agency adoption of situation rooms to manage storm response activities;

- All-Agency adoption of procedures for preemptive curtailment of service when conditions render normal service untenable;

- All-Agency adoption of dedicated customer advocates to ensure the well-being of customers on stuck vehicles;

- Improved procedures to deliver more detailed and reliable bus service status information on the

mta.info web site;

- Improved Buses operating procedures for evaluating and responding to degraded road conditions;

- Improved commuter railroad procedures for ramping up service to meet customer demand during post-storm recovery.

Many of these changes proved effective in contributing to improved performance in subsequent January and February 2011 storms.

1.3. In-depth review

Following the initial Agency reviews, the MTA Chief Operating Officer launched a further in-depth review phase, the results of which are captured in this report. This MTA-wide exercise expanded upon the initial review findings with additional lines of internal and external inquiry. The guiding objective was to identify actions that could improve MTA performance in future storms. The review incorporated lessons learned from the December storm and other storms, along with international good practices in storm management.

More than forty executives and senior managers from across the MTA Agencies and MTA Headquarters were interviewed, to identify key issues around storm management. Past reports assessing MTA performance in 2007[1] and 2004[2] storms were also reviewed to identify lessons learned and open recommendations. Several peer transportation systems from around the world were contacted to provide international perspective on good practices in storm management (Figure 1). Additional documents and storm assessments from other peer transportation systems and agencies including Eurostar and the Federal Emergency Management Agency (FEMA) were also reviewed.
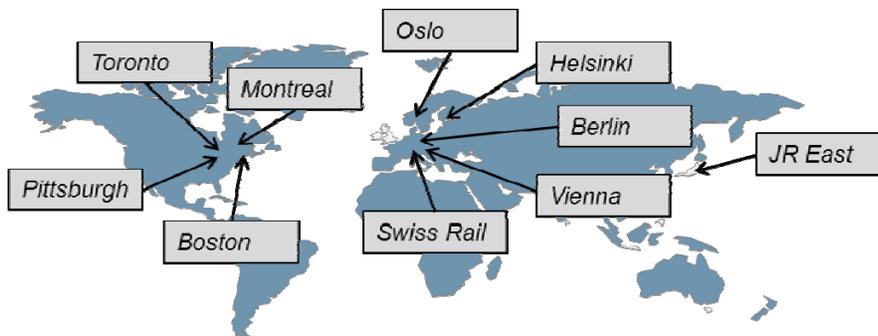
Figure 1: Peer transportation systems from around the world provided feedback to the MTA

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[1] "August 8, 2007 Storm Report", MTA, September 20, 2007.
[2] "Subway Flooding During Heavy Rainstorms: Prevention and Emergency Response", MTA/OIG #2005-64, February 6, 2006.

The MTA continues to monitor the findings of other studies being undertaken to assess the Winter 2010/2011 storms, including reviews by the City of New York and the Massachusetts Bay Transportation Authority (MBTA).

1.4. Findings

Section 2 provides a factual overview of key events that occurred during the December storm. The review is structured according to the four phases of a storm event:

- Storm tracking and readiness, when an approaching storm is monitored and the appropriate response is formulated;

- Mobilization, when storm procedures are activated, staff and other resources are pre-positioned to respond, and customers are informed of potential service disruptions;

- Execution, when the storm arrives, snow and ice clearing commence, operations are adapted to suit conditions, and customers are updated on service status;

- Recovery, when the storm concludes, snow and ice clearing continue, operations are restored, and customers are updated on service recovery.

Section 3 discusses the performance of each MTA Agency through the four phases of the December storm, highlighting both areas of strength and opportunities for improvement.

Section 4 outlines a series of 25 recommendations arising from the review process. These recommendations are targeted towards improving storm performance and are applicable across the MTA Agencies. The recommendations are grouped into four categories: operations, customer communications, staffing, and equipment. Many of the identified issues are also relevant to other disruptions (e.g., floods and power outages) and daily operations. Appendix A lists the recommendations in concise form.

The recommendations have been reviewed in the context of Agency-specific storm performance to develop tailored improvement action plans. These plans are provided in Appendix B and include the status of each action and an indication of which recommendations are being addressed. Ongoing implementation of the action plans will build upon the improvements that have already been achieved since the December storm to further MTA-wide preparedness for future storms.

2. December storm events

2.1. Storm tracking and readiness

The December storm first appeared in weather forecasts as early as Tuesday, December 21. Over the following days, the severity of the impending storm was initially downgraded, although forecasts remained volatile. During this period, the MTA Agencies tracked developments and commenced internal preparations for the storm response. On Saturday, December 25, the storm severity was upgraded and the National Weather Service issued a blizzard warning.

2.2. Mobilization

Over the weekend of December 25 and 26, the MTA Agencies preemptively mobilized staff and equipment for the storm response. This process was complicated by the timing of the storm, which occurred at a time when many employees were granted leave to spend the holidays with their families.

Sunday, December 26 was a major holiday season shopping day, with high MTA-wide ridership. Metro-North reported 55% more customers than on a typical Sunday. The *mta.info* web site reverted to a simplified "weather" home page that displayed the latest service information.

2.3. Execution

Snowfall began across the greater NYC region early in the afternoon of Sunday, December 26. The storm rapidly intensified and from approximately 6 PM onwards, disruptions to transportation and other essential services began to take hold. Amtrak suspended Northeast Corridor services between New York and Boston. Area airports including JFK, LaGuardia, and Newark were closed. The Port Authority also suspended AirTrain service to JFK. New Jersey Transit suspended all bus service.

As snow accumulated, switch problems and snow drifts led to the LIRR implementing its winter storm service suspension policy. Service was suspended to Penn Station and along the Mainline around 8:30 PM, followed an hour later by a system-wide service suspension. Three stuck trains led Metro-North to largely suspend New Haven Line service at 10:30 PM. Several outdoor Subways services were suspended between 9:30 PM and midnight. Buses and Paratransit services were curtailed on an ad hoc basis, as roads became impassible (Figure 2). River crossings operated by B&T remained open throughout the storm.

Figure 2: Buses and Paratransit vehicles became stuck as road conditions rapidly deteriorated

The most significant stranding event of the storm began in the early morning hours of December 27. An A line Subway train carrying over 400 customers became stuck at Aqueduct Racetrack station. Many of the customers had boarded at the Howard Beach-JFK Airport station and were returning home following flight cancellations. The process of recovering the train required more than seven hours.

As snowfall ceased on the morning of December 27, there were significant service disruptions across the region. Many of the MTA fleets had been snowed-in overnight and could not readily be summoned for service (Figure 3). Critical outdoor infrastructure, such as tracks and station platforms, were also inundated with snow in many locations. Metro-North commenced morning rush hour service on the Harlem and Hudson lines, but subsequently suspended all service at 8:45 AM after trains became stuck.

Figure 3: Paratransit vehicles were snowed-in over the night of the storm

2.4. Recovery

After the snowfall stopped on the morning of December 27, employees continued the difficult task of digging out buried fleets and infrastructure, amid drifting wind conditions (Figure 4). These efforts were aided by specialized snow-fighting equipment, including plows, snow throwers, and blowers (Figure 5).

Figure 4: Subways employees faced drifting conditions as they cleared snow on outdoor lines

Figure 5: Specialized snow-fighting equipment complemented manual labor in clearing snow (LIRR snow broom at left, Metro-North jet blower at right)

Limited LIRR and Metro-North services were restored around midday on December 27, using diesel locomotive-hauled trains. Some suspended Subways service started to resume. Buses and Paratransit operated limited levels of service. Amtrak resumed Northeast Corridor service to Boston with delays. The major area airports reopened with limited capacity.

On Tuesday, December 28, Metro-North operated a Saturday schedule, supplemented by additional rush hour trains. LIRR progressively increased service levels throughout the day. The majority of suspended Subways and Buses services were also restored. New Jersey Transit resumed bus service and the Port Authority resumed JFK AirTrain service.

By Wednesday, December 29, regular LIRR and Metro-North services were restored, with the exception of buses providing LIRR service east of Ronkonkoma through December 31. Buses was able to retrieve the last stuck buses. All runways were also cleared at the major area airports.

The operational impacts of the storm were largely resolved by Thursday, December 30, at which time nearly all Subways and Buses services had resumed and the streets of New York City were mostly plowed. Complete restoration of all Buses service was not achieved until Sunday, January 2.

3. Storm performance

3.1. Overview

There was significant variation in how effectively the MTA Agencies managed the December storm. Strengths included instances of early mobilization of storm fighting resources, use of situation rooms to coordinate decision making, and proactive customer communications about service disruptions. Deficiencies included instances when preemptive service curtailment was not effectively used, poor management of stuck vehicles and customers, incomplete customer information about service status, and limited availability of labor and equipment to clear snow and expedite service recovery. The following sections elaborate key strengths and improvement opportunities across the MTA.

3.2. NYCT Subway

Storm tracking and readiness

Subways leadership held multiple planning conference calls in the days leading up to the December storm. These calls reviewed the changing storm forecast and general preparedness for the holiday period. Subways declared a low-level Plan I storm alert on the morning of December 23. However, storm tracking efforts waned over Christmas and the highest Plan IV alert level was only formally declared as the storm arrived on December 26.

Mobilization

Despite the formal Plan I alert status, several procedures from Plan IV were preemptively activated starting on December 25. Subway cars were stored underground, planned infrastructure construction work was suspended, and extra staff was called in. Snow-fighting equipment and work locomotives were preemptively positioned at strategic locations by 7 AM on December 26. Subways formally declared Plan IV at 1:30 PM on December 26.

Execution

A large portion of the underground Subways network delivered uninterrupted service throughout the storm. However, snowfall quickly disrupted service on vulnerable outdoor lines, particularly in south Brooklyn, the Rockaways, and the North Bronx (Figure 6).

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Figure 6: Open cut subway lines were vulnerable to snow accumulation and required several days to be cleared

Subways had stopped using a situation room following the launch of the Rail Control Center (RCC) in 2005. Absent a situation room, key operational decisions were being made in the field, where an insufficient number of experienced managers were available to enable quick and decisive action. Difficulties were exacerbated by the Line Manager organizational structure, which decentralized operational responsibilities for different subway lines. However, ongoing NYPD and NYFD representation at the RCC facilitated external coordination.

As conditions degraded, information about deteriorating conditions and trains losing power or experiencing Brakes in Emergency (BIE) were not effectively passed up the chain of operational command. Furthermore, Plan IV lacked sufficient guidance on preemptive curtailment of service, a practice that had fallen out of use to the point that it was no longer considered to be a viable option at the time of the storm. Consequently, service was ultimately suspended when necessitated by trains becoming stuck on individual lines.

The stranding of over 400 customers aboard an A train at Aqueduct Racetrack station for more than seven hours highlights the complications of rescue operations once trains becomes stuck. The process was prolonged by snow drifts obstructing the subway line and station access roads. Aqueduct Racetrack station is atypical, in that it only operates on a part-time basis and lacks the amenities of most stations. However, during the course of this event, three Subways supervisors were on board the train and able to monitor the well-being of the customers.

Customer communications during the storm were relatively clear and consistent, with service updates provided via the *mta.info* web site. Other channels of communication, including Twitter, were also used to inform customers. However, customers received inadequate guidance about alternate travel plans, due to overestimation of the speed with which service would be restored.

Recovery

Subways developed a prioritized strategy for clearing the Subway infrastructure and restoring service. However, the process was slowed by limited availability of snow-fighting machinery and extensive reliance on manual labor. A shortage of trained operators and disrupted access to the 38th Street Yard in Brooklyn prevented some equipment from being fully utilized. Stuck trains also obstructed efforts to clear lines.

As the recovery progressed, station cleaning staff was transported aboard work trains for improved mobility around the Subway network. However, the process of clearing station platforms was labor-intensive and accomplished without the aid of snow throwing equipment. The diversion of station cleaning resources towards snow clearing also led to a station refuse collection backlog that persisted for a two-week period following the storm.

3.3. Regional Bus

Storm tracking and readiness

Buses issued an initial weather advisory at noon on December 25. A Yellow (low) alert status was declared later that evening, to take effect at 8 AM on December 26. However, the Winter Operations Plan alert levels were not designed to be declared under forecasted conditions that had not yet arrived. Consequently, an elevated Blue alert was only declared at the onset of the storm on the afternoon of December 26. Furthermore, the highest Red alert was never declared at any point during the storm.

Mobilization

Buses began to mobilize personnel and snow-fighting equipment prior to the storm. Night buses and articulated buses were also fitted with snow chains, according to standard procedures. A representative of the Department of Sanitation was dispatched to the Buses Command Center, to aid in coordination of plowing activities. Buses formally declared Blue (medium) alert status at 3:00 PM on December 26.

Execution

Buses lacked a situation room, with oversight instead being provided by the Buses Command Center and several Snow Desks located throughout the five boroughs. This arrangement inhibited coordination of quick and decisive Agency-wide actions. As conditions degraded, depots held back some services that could not be operated effectively. However, there was no coordinated preemptive curtailment effort.

Over 600 buses became stuck during the night of December 26/27. Articulated buses had particular difficulties on the snow-covered streets. Many buses also became stuck attempting to pull into bus stops,

where plowed snow tended to pile up. Stuck buses and customers were tracked by a cumbersome, paper-based process that made it difficult to remain up-to-date as buses became unstuck. There was no manager assigned in a dedicated customer advocate capacity to monitor the welfare of stuck customers and bus operators. However, Buses worked to accommodate stranded customers; in some instances, stuck customers were given rides in 4x4 vehicles used by Buses Road Operations staff.

Operational communications were complicated by the failure of the Buses radio system at 2 AM on December 27. This life-expired system, which dates from 1991, crashed after being inundated by calls from stuck bus operators trying to report back to the Command Center. Quick action by Buses helped to limit the duration of the outage to less than four hours. During that period, efforts to keep track of stuck buses were interrupted, leading to subsequent confusion and double-counting.

Throughout the December storm events, customer information about Buses service was relatively poor. The absence of a structured internal process for aggregating service updates led to information of inconsistent quality. A lack of route-level detail during the storm made it difficult for customers to make educated travel decisions as different routes were suspended and restored.

Recovery

Numerous resources aided the recovery process, including bus operators who volunteered to help dig out stuck buses (Figure 7). B&T also deployed tow trucks and snow-fighting equipment to aid the effort. Coordination of bus recoveries could have been stronger in Brooklyn and Queens, which are geographically contiguous but were being managed by different Snow Desks. The recovery process was prolonged by the high number of buses that had become stuck and ultimately continued until December 29. Buses blocking roadways inhibited street plowing and restoration of service. Full resumption of Buses service was not achieved until January 2.

Figure 7: Bus operators volunteered to help dig out stuck buses

Customers experienced continued difficulties as bus service was restored. Large mounds of plowed snow obstructed many bus stops and some customers waited in the streets and not on the sidewalks (Figure 8).

Figure 8: Even as bus routes were restored to operation, piles of snow posed difficulties for customers

3.4. Long Island Rail Road

Storm tracking and readiness

The LIRR Winter Storm Operating Committee (WSOC) convened on the morning of December 24. Due to the volatility of the storm forecast, the WSOC began planning for the highest Level 4 storm response, even though the immediate forecast coincided with a milder Level 1 storm. Level 4 was formally declared on the afternoon of December 25.

Earlier in 2010, LIRR had launched a campaign to alert customers to the potential for service curtailments during storms with at least 10 to 13 inches of snow accumulation. This proactive outreach helped to raise customer awareness about storm operations.

Mobilization

The LIRR situation room was activated at noon on December 26 and proved effective in centralizing coordination of the storm response.

The LIRR Engineering Department began calling in supplementary staff early on the morning of December 26. At noon, the Public Information Office (PIO) sent out safety messages to train crews. By early afternoon, snow-fighting equipment was strategically positioned throughout the network. LIRR representatives joined OEMs in Nassau and Suffolk County, while the MTAPD served as liaison to the NYC OEM.

Execution

As the storm arrived on the afternoon of December 26, the switches surrounding Jamaica station began to experience problems as early as 3:30 PM. Labor forces deployed to the area proved insufficient to prevent switches from being overwhelmed by snow and ice. The problem was exacerbated by gusting winds, which repeatedly extinguished the powerful gas-fired switch heaters. System-wide delays had reached 20 minutes by approximately 5:30 PM. Continued switch problems at Jamaica station ultimately forced the suspension of service into Penn Station and along the Mainline at 8:30 PM. A proactive decision to suspend all service followed one hour later and prevented any customers from becoming stranded aboard trains. Contributing to the decision were snow accumulations above third rail height, which can cause electric trains to stall.

Comfort trains were deployed to several key stations to provide customers with bathrooms and heated comfortable seating until service was restored. Staff at Penn Station swapped out the comfort trains on the morning of December 27, to ensure continued functionality of bathroom facilities.

The LIRR fleet generally performed well throughout the December storm. Wireless remote monitoring of vital functions on the newest M7 fleet helped to preemptively identify icing conditions that could cause trains to stall.

Recovery

Limited service was restored from 1:30 PM on December 27, using diesel locomotive-hauled trains and replacement buses. In mid-afternoon, a large number of customers stranded at Penn Station were escorted to Jamaica via the Subway, in a coordinated inter-Agency effort. Two LIRR staff received recognition awards from a Huntington social services agency for the support they rendered to a disabled LIRR customer during this process.

Recovery was hindered by low availability of hourly employees in the Maintenance of Way department, which is charged with clearing snow and restoring infrastructure. Contributing factors included the timing of holiday vacations (December 27 was a LIRR holiday) and possible confusion about whether employees who reported would have lost "use or lose" leave that expired at year-end. The deployment of some snow-fighting equipment was delayed by a shortage of trained operators.

Efforts to restore operations were prioritized along the four main branches of LIRR service. As service ramped up during the recovery period, there were difficulties meeting customer demand. Recovery schedules did not provide a sufficient number of trains during the AM/PM rush hours. Train availability was also harmed by slow progress in digging out yards that had become snowed in.

Throughout the recovery, LIRR faced difficulties keeping customers informed about service updates and train schedules. Audio Visual Paging System (AVPS) station information signs needed to be switched off, because the system was incapable of keeping pace with rapidly evolving service conditions. Services that were operating did not generally conform to familiar timetables. Customers were left without a clear understanding of what service to expect until normal service was largely restored on December 29.

3.5. Metro-North Railroad

Storm tracking and readiness

Discussion of the storm response began on December 23, with the first storm operations procedures being activated on December 24. The Metro-North Emergency Management Task Force (EMTF) convened on the morning of December 26, triggering Agency-wide storm coordination.

Mobilization

Metro-North operations personnel began establishing storm coverage and pre-positioning snow-fighting equipment on December 24. The fleet was prepared with special equipment covers, to protect sensitive train components. Maintenance staff was also positioned at Pelham, to provide quick response to any New Haven Line trains that experienced problems during the power supply changeover from overhead catenary to third rail.

The first meeting in the Metro-North situation room was held at 3 PM on December 26 and led to additional preemptive measures. Based upon the intensified storm threat, Metro-North decided to operate a Sunday schedule on Monday, December 27, in order to reduce capacity. This message was rapidly communicated to customers over numerous channels, including the *mta.info* web site and e-mail alerts. Locomotives were also positioned near terminals to support diesel-only operations. The M3 fleet that was known to be vulnerable in storm conditions was removed from service. The Customer Information Center (CIC) was also instructed to remain open all night, to address the expected increase in customer calls.

Execution

Metro-North services operated relatively smoothly on the evening of December 26, during the early hours of the storm. However, three New Haven Line trains became stuck in the vicinity of Pelham between 9:30-10:30 PM. This led to a decision to suspend regular New Haven Line service and helped to minimize further disruption. One of the stuck trains carried 100 passengers, who waited approximately 3 hours 20 minutes to be rescued by a diesel locomotive. At 2 AM on December 27, Metro-North successfully operated a single all-stop diesel train along the New Haven Line, to serve customers remaining at Grand Central Terminal. After that time, a decision was made to fully suspend New Haven Line operations and this was communicated to customers starting at 4 AM.

On the morning of December 27, Metro-North proceeded to operate Sunday service on the Harlem and Hudson lines. However, problems ensued early on when a train that did not carry customers became stuck in Upper Manhattan shortly after 5 AM. Beginning shortly after 6 AM, a series of five customer-carrying trains became stuck in Upper Manhattan and the Bronx. This led to a decision to suspend all services at 8:45 AM to minimize further disruption.

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Customer communications were generally clear and consistent. However, communications to customers at outlying stations around the system were hindered by the limited capacity of the station public address system. Furthermore, the Metro-North Train Time mobile information service was impacted by the IT infrastructure overloading that also affected the *mta.info* web site on the morning of December 27.

Recovery

Limited service was restored across all three lines by 12:30 PM on December 27, less than four hours after the system-wide suspension was declared. Services were re-opened on the Danbury, New Canaan, and Waterbury branch lines later in the afternoon.

The Metro-North recovery process was aided by effective coordination and deployment of labor forces and snow-fighting equipment. Contracted labor assisted in clearing platforms at seven stations. Some difficulties were experienced concerning the availability of signals staff, due to Federally-mandated restrictions on hours of duty.

By December 28, Metro-North was able to meet its goal of operating a Saturday schedule. However, customers experienced difficulties because the Saturday schedule did not provide enough trains to meet demand during the rush hours. Administrative staff deployed at stations and on trains helped to provide feedback on crowding conditions. Operations responded by adding some supplementary trains, although this was hindered by a shortage of trains that were ready for service. Some customers were left waiting on platforms for as much as an hour until the next train arrived.

Customer communications during the recovery process were aided by the adoption of a familiar Saturday schedule on December 28 and the resumption of normal weekday service on December 29.

3.6. Paratransit

Storm tracking and readiness

As a subsidiary of Buses, Paratransit did not have the ability to declare storm alert levels independently from Buses and was subject to the limitations discussed in Section 3.3.

Mobilization

The Buses Winter Manual included a set of Paratransit-specific procedures that helped in mobilizing the storm response. The Paratransit storm center was activated at 6 PM on December 26.

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Execution

Paratransit followed historical practice in aligning its December storm response with the wider Buses response. As a result, there was no effort to preemptively curtail service.

Many Paratransit customers had traveled away from home during the first half of December 26, prior to the start of the storm. These customers later needed rides home, even as road conditions deteriorated. By 9 PM on the night of December 26, there were approximately 134 stuck paratransit vehicles, stranding 34 customers. The rear-drive sedan fleet proved more susceptible to becoming stuck than the van fleet, due to a less favorable weight distribution. Efforts to reach stranded customers were hampered by poor road conditions. Paratransit reverted to calling 911 for assistance in rescuing some customers, although this arrangement was not very effective.

Because the Paratransit fleet is equipped with an Automatic Vehicle Location Monitoring (AVLM) system, drivers were able to exchange two-way messages with the storm center regarding road conditions and other operational issues. This helped to maintain coordinated communications throughout the course of the storm.

Coordination with the Department of Sanitation helped to ensure that the roads leading to Paratransit depots were kept clear. Prevailing road conditions were better in Nassau County than in New York City, as a result of more extensive plowing.

Recovery

Paratransit used its Paratransit Automatic Notification System (PANS) to automatically call customers and alert them to service disruptions, with a 70% success rate. On December 27, the demand for Paratransit trips had dropped to approximately 1/5 the normal volume, which helped to keep the fleet off the roads as plowing operations were still underway. Paratransit customers were also kept informed of service updates through the *mta.info* web site, the Paratransit hotline, and media outlets.

3.7. Bridges and Tunnels

Storm tracking and readiness

Early on the morning of December 25, B&T identified the severity of the impending storm and initiated the storm mobilization process.

Mobilization

Beginning on the morning of December 25, B&T summoned additional maintenance and operations staffing coverage. During the afternoon, the Operations Central Command and Control (OCCC) issued a

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pair of storm preparedness notifications outlining the storm response plan. These included information on staffing, chain of command, and weather forecasts. Labor resources and equipment were strategically deployed beginning on the morning of December 26. Adequate levels of deicer were stored and available.

Execution

The B&T response was highly effective, with the result that no service interruptions were experienced.

B&T snow-fighting vehicles were equipped with GPS tracking, which aided in coordination of snow clearing activities (Figure 9). B&T was also able to deploy some of its equipment to assist Buses in removing stuck buses.

Customer information via the *mta.info* web site and other channels was consistent and coordinated throughout the storm.

Figure 9: Snow-fighting equipment helped prevent the need for B&T service interruptions

Recovery

Proactive management of snow and ice conditions during the storm obviated the need for extensive post-storm recovery operations. B&T quickly assessed and assured the serviceability of its fleet, achieving 94% availability on December 28.

4. Recommendations

4.1. Overview

Twenty-five recommendations for improving MTA-wide storm performance have been grouped into four categories: operations, customer communications, staffing, and equipment. While the recommendations are targeted towards improving storm performance, many of the identified issues are also relevant to other disruptions (e.g., floods and power outages) and daily operations. The recommendations are listed in concise form in Appendix A.

As described in Section 3, each MTA Agency faced unique challenges in the December storm and demonstrated different strengths and weaknesses. The recommendations have been reviewed in the context of Agency-specific storm performance to develop tailored improvement action plans. These plans are provided in Appendix B and list each action with current status and target completion date. Some of these actions have already been implemented and proven effective in the January and February storms.

4.2. Operations

> *Recommendation 1: The MTA Agencies should coordinate storm operations and share information, with MTA-wide coordination facilitated by a dedicated Emergency Coordinator.*

Coordination enables a collectively-strong MTA-wide response to storm events. The MTA Agencies coordinated on many fronts during the December storm. The *mta.info* web site provided customers with a single source of information on MTA-wide operations. LIRR and Subways cooperated to escort stranded LIRR customers from Penn Station to Jamaica via the Subway. Buses and Paratransit exchanged frequent updates on road conditions. However, these examples were overshadowed by the lack of MTA-wide strategic alignment concerning the timeliness and magnitude of the Agency storm responses. Highlighting the divergence, LIRR had declared the highest state of readiness on the morning of December 24, whereas Subways had not activated the highest alert even as snow began to fall on the afternoon of December 26.

Subsequent to the December storm, the MTA has appointed a dedicated full-time Emergency Coordinator to improve MTA-wide storm coordination and provide ongoing oversight of storm readiness. The Emergency Coordinator facilitates executive-level conference calls that enable aligned MTA-wide decision-making. Throughout a storm event, the Emergency Coordinator also remains in contact with senior operating managers to share forecasts and other information between Agencies. This new arrangement was effectively demonstrated during the January and February storms. Outside of storm events, the Emergency Coordinator will examine the storm procedures of each Agency to identify shortcomings, guide improvements, and share best practices. This will be an ongoing process, as the Agencies have always reviewed and updated their storm procedures on an annual basis.

MTA-wide coordination is not intended to constrain the operational flexibility of each Agency. The Agencies operate different transport modes in varied geographies amidst unique constraints. There are no one-size-fits-all procedures or decision-making criteria that can be uniformly applied across the MTA. The most effective coordination mechanism is to provide open channels of communication and information exchange through all phases of a storm event.

> *Recommendation 2: Agencies should develop tailored storm operating procedures with graduated levels of storm response. Such procedures should accommodate differing degrees of storm severity across the service regions and be supported by effective operating command structures.*

At the time of the December storm, each of the Agencies had storm operating procedures with graduated levels of response that could be activated depending upon the severity of a storm. This is a fundamentally sound approach that is also used by peer transit systems. However, the December storm highlighted shortcomings in Agency procedures that require improvement. The Subways procedures did not stipulate guidelines for when to activate storm alert levels relative to forecasted storm arrival. The Buses procedures did not emphasize the ability to prospectively activate the storm response before snow accumulation had started. Furthermore, the procedures were not adapted towards enabling different degrees of response according to localized road conditions. Paratransit was tied to Buses storm procedures, which did not enable basic measures such as curtailing service for non-essential trips. All of the Agencies are reviewing their procedures and making updates, as highlighted in Appendix B.

The volatility of the December storm necessitated early and decisive action to mobilize an effective response. This process was hindered at Subways by the Line Manager organizational structure, which had been in place since 2009. The Line Manager structure distributed operational management across each Subway line and complicated the unified command and control that is required in a storm event. Subways has subsequently taken action to return to a more conventional centralized operating structure that will enhance responsiveness in future storms.

> *Recommendation 3: Storm operating procedures and situation rooms should be ready and activated for use prior to the arrival of a storm, to facilitate coherent and rapid decision-making.*

Situation rooms enable senior management to quickly share information, make decisions, and communicate instructions through the chain of command. LIRR and Metro-North effectively used their situation rooms during the December storm, with LIRR also employing a subsidiary situation room for coordinating Maintenance of Way (infrastructure) activities. Subways and Buses did not have situation rooms at the time of the December storm and this made it difficult to coordinate key decisions such as whether and when to curtail service. Both have subsequently established situation rooms and these were effectively utilized during the January and February storms. MTA-wide coordination is achieved through teleconferences, so that Agency executives can participate while remaining on location at their respective Agency situation rooms.

Recommendation 4: Equipment and labor forces should be pre-positioned at strategic locations prior to the arrival of a storm, to maximize the effectiveness of available resources.

Each agency has known operational vulnerabilities in storm conditions. Trains on the Metro-North New Haven Line can lose power during the changeover from overhead catenary to third rail power at Pelham. In the December storm, Metro-North pre-positioned maintenance staff at Pelham, so they were able to quickly respond when trains began to encounter difficulties. Buses is now developing procedures for pre-positioning tow trucks at key locations in its network in case of stuck buses.

Recommendation 5: Coordinated procedures should be developed with interdependent stakeholders, such as the Department of Sanitation.

Just as there are internal MTA-wide storm procedures, coordinated procedures with interdependent stakeholders are a critical aspect of storm performance. During the December storm, Paratransit collaborated closely with the Department of Sanitation to ensure that the streets serving Paratransit depots were given plowing priority. A representative of the Department of Sanitation was also present in the Buses Command Center, to facilitate coordination of plowing and bus operations. Buses is now working with the Department of Sanitation to extend this cooperation and develop a set of plowing procedures that will support continued operation of pre-defined priority bus routes during storms. This advanced planning mirrors good practice observed in Montreal, where the city and bus operator (STM) have developed joint road plowing procedures. Priority bus routes will be selected based upon factors including ridership and proximity of Subway lines. New real-time plowing data that will become available as the Sanitation fleet is retrofitted with GPS should be shared, to provide Buses and Paratransit with the ability to map out road conditions along bus routes and enhance proactive management of operations during storms. A new Tow Truck Task Force (TTTF) is also being coordinated by the OEM to facilitate sharing of tow truck resources between several municipal agencies. Buses participated in the TTTF during the January and February storms.

Another crucial interdependency is between Buses and CEMUSA, which has a NYC DOT franchise to maintain 3,200 bus shelters. During a storm, CEMUSA is responsible for clearing snow in and around shelter areas. Establishing coordinated procedures with CEMUSA could help to ensure improved service for Buses customers in future storms.

Recommendation 6: Storm operating procedures should include provisions for controlled service curtailment. Leadership should be prepared to preemptively activate these procedures when conditions render normal service untenable.

During exceptional storm conditions such as those experienced in December, preemptive service curtailment up to and including full suspension may be a necessary course of action. Curtailing service in a controlled manner prevents vehicles from becoming stuck, which could strand customers and employees

and damage equipment. The avoidance of stuck vehicles prevents the need for recovery operations and allows for faster snow removal, both of which contribute to a more expedient return to normal service. LIRR successfully applied its service curtailment policy in the December storm, with the result that no customers were stranded aboard stuck trains.

The December storm demonstrated that even where curtailment procedures exist, organizational culture sometimes prevents controlled curtailment from being considered a viable option. Subways and Buses services continued to run, even after significant numbers of vehicles had become stuck. Subways has subsequently reorganized its operating structure and is revising its storm plan to prevent this from happening in future storms. Buses took action to preemptively suspend all service during a storm on January 27, with the result that service was quickly restored once road conditions had improved. Paratransit curtailed service during the January 11/12 and January 27 storms, successfully demonstrating the effectiveness of several new procedures associated with preemptively notifying customers and curtailing operations.

Consultation with peer properties confirms that preemptive service curtailment is a good practice for storm operations. The MBTA in Boston has developed a set of curtailed bus "snow routes" that can be activated in storm conditions and are published on its web site. Oslo provides staff with "action cards" that list pre-defined curtailment procedures for a large number of scenarios, to prepare employees for a coordinated curtailment response.

Recommendation 7: Storm operating procedures should address management of stuck vehicles, including protocols for attending to customer needs until rescue is practicable. Situation rooms should include dedicated customer advocates to ensure the well-being of customers on stuck vehicles.

The most critical aspect of managing stuck vehicle events is attending to the needs of stuck customers. It is imperative to provide these customers with information, as well as medical care if necessary. Amenities should also be provided wherever practicable. To facilitate this process, one or more senior managers should be assigned to each Situation Room as dedicated customer advocates. Since the December storm, Subways and Buses have established customer advocate roles.

All of the Agencies have experience managing stuck vehicle events under a variety of circumstances. When vehicles become stuck during storms, there may be specific complicating factors that need to be addressed. In the December storm, the most significant stuck vehicle event involved a Subway train on the A line that became stuck at Aqueduct Racetrack station. Procedures are being reviewed to identify ways that rescues under these difficult circumstances can be expedited in the future.

There are also unique challenges associated with managing stuck buses and Paratransit vehicles. In the December storm, more than 600 buses and 130 Paratransit vehicles became stuck on streets overnight. Since December, both Agencies have been refining their procedures for monitoring the location of stuck vehicles and the status of customers on board. Buses has been using improved stuck bus data from the January and February storms to identify contributing factors that lead to stuck buses. Buses is also developing a Snow Desk application that automates the tracking process, while Paratransit is taking advantage of its Automatic Vehicle Location Monitoring (AVLM) system to develop a program that

automatically detects and maps out the locations of immobile vehicles. Paratransit is also coordinating with the New York City OEM to improve procedures for rescuing customers who do become stranded.

Recommendation 8: Storm operating procedures should include weekday service recovery schedules that provide reduced levels of service aligned to the AM/PM peaks of weekday customer demand.

During storm recovery, curtailed services are progressively ramped back up to normal levels as conditions improve. Both commuter railroads experienced difficulty aligning restored service with customer demand on the weekdays following the December storm. Both railroads reverted to weekend schedules, which provide approximately 40% as many trains as a normal weekday schedule. However, weekend schedules are not well suited to the pronounced AM/PM rush-hour demand experienced on weekdays. During the December storm, the railroads monitored crowding and inserted extra trains on an ad hoc basis during the rush hours. However, there were operational limitations to the number of trains that could be added and many customers experienced long waits as a result. The railroads are now developing revised strategies for weekday recovery that can provide more trains than a weekend schedule while aligning to the AM/PM peaks of weekday customer demand.

Recommendation 9: "Table top" practice exercises should be organized on a recurring basis to test and refine storm operating procedures.

"Table top" practice exercises allow the Agencies to test and refine storm procedures on an ongoing basis, to improve preparedness for actual storms. Subways and Buses took advantage of mild storms in January and February to mobilize their new situation rooms in conditions that did not otherwise require that level of response. These efforts enabled successful testing and refinement of storm coordination processes.

4.3. Customer communications

Recommendation 10: Proactive outreach should alert the public to the possibility that travel may be disrupted and service curtailments or modifications may be necessary during severe storms.

Proactive, coordinated public communications should be used to alert customers to the potential for service curtailments during severe storms. Providing this information manages customer expectations and enables informed travel decisions. Some customers may elect to forego non-essential travel if there is a possibility that service curtailment would interfere with the return trip. The LIRR launched a campaign in February 2010 for alerting customers to expect curtailments when snow accumulations reach 10-13 inches (a point at which snow obstructs third rail power supplied to trains). The widespread awareness raised by this campaign helped to prepare customers for the curtailments that were required in the December storm. Other Agency campaigns also promote winter weather awareness, such as the Metro-

North "Guide to Winter Travel" that is now in its ninth installment.

Proactive outreach was also observed at peer properties. WMATA in Washington, DC publishes a flyer promoting winter service plans that include measures such as underground-only Metro operation and curtailed bus routes (Figure 10). The flyer follows a similar approach to the LIRR campaign, by including specific criteria that manage customer expectations, such as indicating that Metro curtailment should be expected when there is more than 8 inches of accumulated snow.
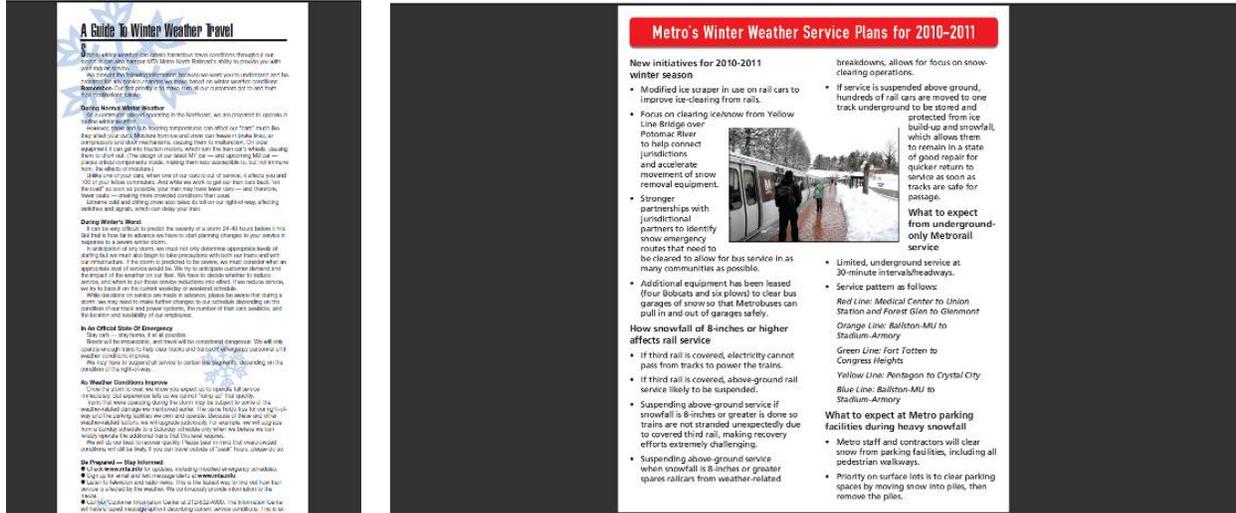
Figure 10: Flyers can be part of a proactive winter outreach, such as these examples from Metro-North (left) and WMATA in Washington, DC (right)

> *Recommendation 11: The* mta.info *web site should provide real-time route-specific information that will enable customers to make informed decisions on how to modify their travel plans during storms.*

The *mta.info* web site provides MTA customers with a single resource for information on all MTA services. During the December storm, the MTA followed established procedures by activating a special *mta.info* home page, which provided customers with immediate access to critical service updates (Figure 11). The MTA is focused on improving the quality of real-time service information that customers receive through the site. There is a particular challenge associated with providing accurate information on bus services, which are distributed across 345 routes throughout the Metropolitan area. Subsequent to the December storm, Buses revised the procedures used to aggregate and transmit service information, enabling more accurate and timely route-level service information to be posted during the January and February storms. Ongoing deployment of the Bus Time system will also improve access to real-time customer information during storms, just as it does during routine operations.
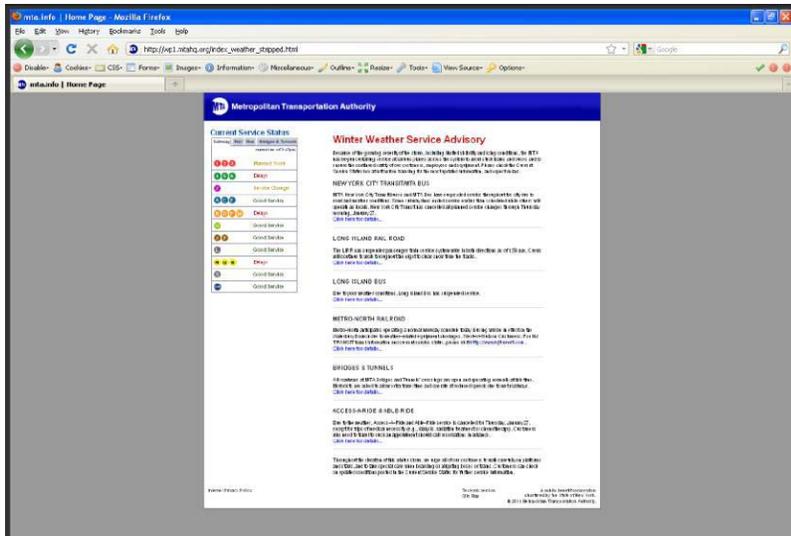
Figure 11: The *mta.info* web site adopts a simplified design during storms, with direct access to service updates

> *Recommendation 12: Multiple channels of communication, including 311, and social media, should be used to provide customer information and obtain real-time customer feedback during storms.*

The *mta.info* web site is the most comprehensive source for service status information. Additional channels of communication expand the ability to reach MTA customers, whether at home or on the go. Thousands of MTA customers have signed up for e-mail and SMS service alerts through the *mymtaalerts.com* web site. These alerts provided critical service updates during the December storm. Mobile tools such as Metro-North Train Time (Figure 12) and the CooCoo SMS service adopted by the commuter railroads also provide service information on the go. Social media provides a further channel and is exemplified by Twitter updates posted to several MTA Agency feeds during the December storm. Looking forward, new opportunities to share real-time service information with the developer community could enable mobile applications that will enhance customer information during future storm events.

Many MTA customers also rely on voice telephony to obtain service information. The MTA recently consolidated its hotlines to provide customers with easy choices for dialing in. During the December storm, the Subways and Buses Travel Information Center (TIC) used an Interactive Voice Response (IVR) system to provide customers with service status information, including an "up-front" service update message. Paratransit is deploying a new IVR system that will place automated calls alerting customers to impending storm conditions and facilitate proactive trip cancellations. Additionally, the NYC 311 hotline helps to connect callers with MTA service status information, which is also displayed on the 311 web site. On December 27, there were 35,000 callers transferred from 311 to the MTA hotlines. In subsequent talks with the City Department of Information Technology & Communications (DoITT), new procedures were established for improving coordination with 311 during future storms.

Other communications innovations are also being pursued. LIRR has partnered with Madison Square Garden (MSG) to display urgent messages about service suspensions on the 7th Ave marquis outside

Penn Station. Expanding cell phone coverage to underground Subway platforms, as recommended in the 2007 MTA storm report, could enhance the ability of customers to communicate and receive mobile service updates during storms. Expanded cell phone coverage could also help to improve communications between operating staff.

Figure 12: Customer demand for service information on the go from services such as Metro-North Train Time has been strong

The MTA is also pursuing new means to obtain real-time customer feedback during storms. Cooperation with the developer community could facilitate mobile applications that enable "crowd-sourced" information, such as the ability for customers to post photos of conditions at stations. MTA Twitter feeds and Facebook sites also facilitate real-time feedback from customers. Furthermore, improved protocols will enhance the ability to monitor feedback from MTA-related 311 and 911 calls during storm events.

> *Recommendation 13: The* mta.info *web site and other online services should be supported by robust IT infrastructure with capacity to serve the increased customer demand experienced during storms.*

Routine traffic on the *mta.info* web site has been increasing at 10% per year, due to increased regional population and the proliferation of web-enabled mobile devices. During a significant storm, *mta.info* can experience ten-times the normal level of traffic. On the morning of December 27, *mta.info* demand exceeded the IT infrastructure capacity of 500,000 concurrent users. This also impacted users of the Metro-North Train Time mobile information service. Subsequent upgrades have been undertaken to the data links, servers, and firewalls to increase the capacity to an estimated 1.2 million concurrent users. The IT infrastructure of *mta.info* and other services such as *mymtaalerts.com* should be continually reviewed and upgraded to ensure sufficient capacity to meet growing demand.

> *Recommendation 14: Storm-specific communications procedures should be used to provide service information to customers traveling within the MTA network.*

For customers already traveling within the MTA network, public address systems, display signs, and MTA staff are the main sources for information; especially in underground portions of the network without cell phone coverage. Storm-specific communications procedures should be implemented to keep customers informed about changing service conditions. Public address announcements usually become the primary means for communicating service updates. During a storm, there needs to be a procedural shift from making announcements about disruptions "by exception" towards "active" use of announcements to let customers know about all services that are operating. This is especially critical when atypical curtailed services are in operation. Staff resources and equipment should be available to handle the increased volume of public address traffic. Metro-North is in the process of upgrading the capacity of its public address system, which will facilitate improved communications in future storms.

Next train arrival signs and automated displays that are relied upon for routine service information may not operate correctly once service substantially deviates from the normal schedule. During the December storm, the Audio Visual Paging System (AVPS) displays on LIRR station platforms needed to be switched off, because the information being communicated did not reflect the curtailed service. LIRR subsequently implemented upgrades to improve the robustness of the AVPS system during storm operations and reduce the lead time needed to upload special storm recovery schedules.

4.4. Staffing

> *Recommendation 15: Procedures for maximizing work force availability during storms should be developed and implemented.*

A high concentration of staff is required to manage a severe storm event. Work force availability can become a primary limitation in the effort to maintain and restore service. This was evident in the December storm, when Subways and LIRR required several days to clear snow from infrastructure and restore service (Figure 13). The key opportunity for maximizing labor availability is early and decisive mobilization. To the extent possible, forces should be mobilized before snowfall begins, after which time difficult road conditions and service suspensions are a hindrance. Automated call-in systems are being explored to reduce the lead-time associated with manually calling in staff from a roster than could be hundreds of names long. Work rules should also be re-evaluated to ensure that the work force can be proactively mobilized in instances that require reporting to work outside of normal tours of duty. Provisions should be established to ensure that employees who report for snow duty will be compensated for vacation entitlements that they otherwise would have taken, particularly around the holiday season.

Figure 13: Employee availability is critical during the labor-intensive process of clearing infrastructure

Recommendation 16: To the extent possible, labor resources should be flexibly utilized according to both geographic assignments and work functions during storms.

The ability to flexibly deploy labor resources during a storm is vital. In appropriate circumstances, allowing employees to report to the closest available reporting location can make the difference in being able to report to work. In the December storm, Subways station cleaners were able to report to any station and call in to receive appropriate assignments. Conversely, there are other instances where this had been tried in the past and found to be ineffective. Enabling bus operators to report to the nearest depot had been tried in past storms, but the policy was abandoned because variations in equipment and bus route details made it difficult to redeploy operators.

Functional flexibility is also useful in enabling staff to adapt to roles that are required in storms. Subsequent to the December storm, the LIRR has expanded the range of staff trained to operate snow-fighting equipment. The LIRR has also provided additional training to station cleaners to enable them to clear snow from station platforms, thereby freeing up Maintenance of Way staff to clear other infrastructure, such as switches.

Recommendation 17: Administrative staff should be mobilized in support roles, such as assisting customers with information and monitoring station crowding during severe storms.

Mobilizing administrative staff in appropriate support roles can be an important means for supplementing labor resources during a storm. The commuter railroads have longstanding formalized programs for deploying administrative staff during significant operating events. In the December storm, Metro-North administrative employees were posted to help provide customer information and monitor crowding on station platforms and trains. Subways and Buses are evaluating the benefits of establishing similar programs.

> *Recommendation 18: Supplementary labor resources should be utilized in instances where in-house forces are insufficient to keep pace with severe storms.*

Storm responses are largely constrained by the availability of labor resources. This is underscored by the duration of time that Subways and LIRR required to restore infrastructure following the December storm. There may be opportunities to utilize contracted supplemental labor under these circumstances. One example is an on-call contract that Metro-North has established with a contractor for removing snow from platforms at seven pre-determined stations. During the December storm, this contract enabled Metro-North to deploy in-house forces elsewhere to remove snow from other critical infrastructure. This approach has also been adopted by the Department of Sanitation, which hires supplemental snow labor each winter. B&T is also adding line items to new contracts that will require contractors to share in the responsibility for snow removal.

> *Recommendation 19: Transportation staff training should include winter operations procedures and crisis management techniques for acute service disruptions, such as stuck vehicles.*

The MTA is committed to ongoing staff training, including in the area of winter operations. The December storm highlighted areas for improving the training curriculum, particularly at Buses. Bus operator training is being revised to include improved guidance on snow operations, such as specific techniques for articulated buses and avoidance of getting stuck at bus stops.

Although there were no significant altercations reported during the December storm, a further area for review relates to how front-line transportation staff (e.g., conductors and station agents) is trained to manage crisis situations. During acute service disruptions, such as stuck vehicle events, crisis management techniques can help to diffuse stress levels among staff and customers and maintain safety and order. The commuter railroads already incorporate these principles as part of the Federally-mandated Train Emergency Accident Management (TEAM) training program. A review of international practice further confirmed the value of crisis management training. The Eurostar Independent Review recommended staff crisis management training inspired by the airline industry after snow-induced failures trapped several trains in the Channel Tunnel in December 2009[3].

4.5. Equipment

> *Recommendation 20: Robust radio and communication systems should provide capacity to serve the increased operational demand experienced during storms.*

The Buses radio system that bus operators use to communicate with the Buses Command Center experienced a complete failure lasting nearly four hours in the early morning of December 27. The system

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[3] "Eurostar Independent Review", February 12, 2010.

was overloaded as numerous bus operators simultaneously called in to report stuck buses and impassible road conditions. The life-expired radio system is no longer supported by the original equipment manufacturer and is currently slated to be replaced in the 2018 Capital Program. In the interim, some upgrade modifications were completed to help prevent future outages and Buses is also reviewing procedures for how to communicate in the event of a subsequent failure.

The Agencies generally reported that field operational communications were otherwise effective during the December storm. The use of mobile phones, BlackBerrys and Nextel radios provided numerous channels for communicating with operating staff. Paratransit vehicles are also equipped with an Automatic Vehicle Location Monitoring (AVLM) system that enables two-way transmission of text messages. This system proved effective in the December storm by helping drivers to report road conditions to the command center.

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Recommendation 21: Real-time monitoring technologies such as GPS and wireless video should be used to enable proactive management of vehicles and infrastructure.

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The expansion of real-time monitoring technologies across the MTA fleets enhances the ability to manage storm operations and provide customers with service updates. Paratransit has equipped nearly its entire fleet with GPS, which allows real-time monitoring of vehicle locations. B&T snow-fighting equipment is also tracked with GPS. LIRR has fitted GPS-tracking to its support vehicle fleet (e.g., service trucks) and its snow-fighting equipment. During the December storm, this helped LIRR to review sections of the infrastructure that had been plowed and oversee resource deployment (Figure 14). The GPS-enabled Bus Time system that has been piloted on the B63 route and is now being deployed throughout Staten Island will enhance the ability to monitor bus locations during storms and provide customers with updates. Other Agencies are also investigating the potential benefits of installing GPS on both support and revenue fleets. Subways is also pursuing a New Technology Signals system that will provide the Rail Control Center (RCC) with the ability to remotely monitor train locations on the B-division (lettered lines), similar to the capability that is already available on the A-division (numbered lines).

One of the most advanced forms of real-time monitoring employed during the December storm was the Wireless Monitoring and Detection System (WMDS) fitted on the commuter railroad M7 fleets. This system provided the ability to remotely monitor the power that each train was collecting from the third rail. Engineers used WMDS to monitor trains that were in service and take preemptive actions to prevent trains from losing power and stalling.

Real-time wireless video is another important tool for remotely monitoring field conditions during a storm. Metro-North is looking at ways to provide its situation room with video feeds from cameras on station platforms and other infrastructure. Subways is planning to install wireless video cameras on diesel work locomotives that are frequently used in storms.

Figure 14: Real-time GPS tracking of support vehicles and snow-fighting equipment aided decision-makers in the LIRR situation room

Recommendation 22: Each Agency should maintain snow-fighting equipment that suits its unique infrastructure needs and is maintained in a state of good repair.

Each Agency has developed a set of recommendations on new snow-fighting equipment that could be purchased to improve preparedness for future storms. Subways is in the process of procuring eight new snow throwers. This equipment will enable Subways to pre-position snow throwers on each of the vulnerable open cut subway lines in future storms. Subways is also increasing the number of deicing cars and pursuing a battery-operated snow thrower pilot for clearing station platforms. The LIRR reviewed snow-fighting equipment in use at several properties around the world and has recommended the purchase of a large "spreader" plow, which will improve its ability to clear infrastructure. Metro-North is pursuing additional cold air blowers (Figure 15), which will be capable of clearing snow from the tops of trains. This should help to prevent failures of the New Haven Line legacy fleets, which are caused by snow ingestion from rooftop vents. The criticality of maintaining an effective fleet of snow-fighting equipment underscores the importance of Capital Program funding, which is required to purchase this equipment.

Figure 15: Cold air blowers such as this one at Metro-North can rapidly clear snow

A survey of snow-fighting equipment around the world indicated that many properties use similar types of equipment as those employed by the MTA agencies. Examples of new developments were also found, such as a third rail clearing machine that is being tested in Finland (Figure 16).

Figure 16: This novel machine from Finland can help to clear third rail snow and ice buildup

Where practical, snow-fighting equipment should also be shared across the MTA. This is particularly relevant for B&T, which deployed some of its equipment to support Buses and Paratransit during the December storm. B&T is developing a formalized procedure to facilitate equipment sharing in future storms.

Recommendation 23: Fleets and infrastructure should be permanently modified or seasonally winterized to address known vulnerabilities and maximize storm preparedness.

The December storm highlighted several vulnerabilities of both fleets and infrastructure. Many of these shortcomings can be addressed through permanent modifications or seasonal winterization measures. Subways is developing a software upgrade that will improve the ability of newer trains with computer-controlled traction systems to operate under third rail icing conditions. The LIRR is examining ways to prevent snow accumulation on train car couplings and modifying diesel locomotives to prevent snow-ingestion that can lead to failures.

The Agencies have also been examining ways to improve infrastructure performance in storms. Subways and the commuter railroads have been reviewing and upgrading heating elements that prevent snow and ice accumulation at key locations along the tracks and switches. In one example, the December storm revealed unprecedented icing on the approaches to the Williamsburg Bridge, so Subways has installed new heating elements to combat this issue. Subways is also engaged in a New York Power Authority (NYPA)-financed program[4] to upgrade third rail heaters with wireless controllers (Figure 17). This technology allows heaters to be switched on an as-needed basis, as opposed to always being on, saving an estimated $793,000 in annual electricity costs. The system can also detect failed heating elements, enabling proactive repairs before icing occurs.

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[4] NYPA provides financing for material; labor is being funded by a Transit Initiatives for Greenhouse Gas and Energy Reduction (TIGGER) grant that was competitively awarded to the MTA

MTA Storm performance review

Figure 17: New wireless controllers for Subway third rail heaters reduce costs while improving reliability

Buses has also been investigating a series of measures that are designed to improve the road-going capabilities of its fleets in snow conditions. Subsequent to the December storm, tests were conducted to identify optimal combinations of tires and snow chains on different types of buses. A pilot is also being undertaken to evaluate the benefits of year-round operation with snow tread tires. This could eliminate the need to install snow chains in preparation for each storm, which is a labor intensive process that disrupts normal maintenance operations.

Paratransit plans to increase the proportion of 4-wheel drive vehicles in its support fleet, so that field operations managers will be able to negotiate difficult road conditions during storms. Snow chains have also been purchased to improve the road-going capabilities of 10% of the Paratransit vehicle fleet, which should be sufficient to meet the reduced service demand experienced in a storm.

Recommendation 24: Fleets that are most vulnerable to storm conditions should be substituted out of operation during storms.

Some vehicle fleets have inherent characteristics that increase vulnerability in storms. In such instances, better performing vehicles should be substituted to the extent possible. Procedures are being developed to substitute out Paratransit sedans for more snow-capable vans. Similarly, Buses is developing procedures to substitute out articulated buses for conventional 40-foot buses, which can negotiate snow more easily.

The January 11/12 storm resulted in severe difficulties for the Metro-North M2, M4 and M6 legacy fleets on the New Haven Line. A significant proportion of the fleet was immobilized and services needed to be curtailed for one month while repairs were being completed. New M8 trains with improved AC motor technology are less vulnerable to snow-related failures and will greatly improve the reliability of Metro-North storm operations.

Recommendation 25: Uninterrupted capital investment should be maintained to ensure the storm preparedness of the MTA fleet and infrastructure.

The future storm preparedness of the MTA is dependent upon continued capital investment to fund necessary replacement and upgrades of fleets and infrastructure. Vital capital projects to enhance real-time service information, replace the life-expired Buses radio system, and deliver M8 trains for the Metro-North New Haven Line underscore the importance of uninterrupted capital investment. An inability to deliver these and other capitally-funded initiatives will compromise the storm performance of the MTA.

Appendix A – Tables of recommendations

Operations	
1	The MTA Agencies should coordinate storm operations and share information, with MTA-wide coordination facilitated by a dedicated Emergency Coordinator.
2	Agencies should develop tailored storm operating procedures with graduated levels of storm response. Such procedures should accommodate differing degrees of storm severity across the service regions and be supported by effective operating command structures.
3	Storm operating procedures and situation rooms should be ready and activated for use prior to the arrival of a storm, to facilitate coherent and rapid decision-making.
4	Equipment and labor forces should be pre-positioned at strategic locations prior to the arrival of a storm, to maximize the effectiveness of available resources.
5	Coordinated procedures should be developed with interdependent stakeholders, such as the Department of Sanitation.
6	Storm operating procedures should include provisions for controlled service curtailment. Leadership should be prepared to preemptively activate these procedures when conditions render normal service untenable.
7	Storm operating procedures should address management of stuck vehicles, including protocols for attending to customer needs until rescue is practicable. Situation rooms should include dedicated customer advocates to ensure the well-being of customers on stuck vehicles.
8	Storm operating procedures should include weekday service recovery schedules that provide reduced levels of service aligned to the AM/PM peaks of weekday customer demand.
9	"Table top" practice exercises should be organized on a recurring basis to test and refine storm operating procedures.

Customer communications	
10	Proactive outreach should alert the public to the possibility that travel may be disrupted and service curtailments or modifications may be necessary during severe storms.
11	The *mta.info* web site should provide real-time route-specific information that will enable customers to make informed decisions on how to modify their travel plans during storms.

12	Multiple channels of communication, including 311, and social media, should be used to provide customer information and obtain real-time customer feedback during storms.
13	The *mta.info* web site and other online services should be supported by robust IT infrastructure with capacity to serve the increased customer demand experienced during storms.
14	Storm-specific communications procedures should be used to provide service information to customers traveling within the MTA network.

Staffing	
15	Procedures for maximizing work force availability during storms should be developed and implemented.
16	To the extent possible, labor resources should be flexibly utilized according to both geographic assignments and work functions during storms.
17	Administrative staff should be mobilized in support roles, such as assisting customers with information and monitoring station crowding during severe storms.
18	Supplementary labor resources should be utilized in instances where in-house forces are insufficient to keep pace with severe storms.
19	Transportation staff training should include winter operations procedures and crisis management techniques for acute service disruptions, such as stuck vehicles.

Equipment	
20	Robust radio and communication systems should provide capacity to serve the increased operational demand experienced during storms.
21	Real-time monitoring technologies such as GPS and wireless video should be used to enable proactive management of vehicles and infrastructure.
22	Each Agency should maintain snow-fighting equipment that suits its unique infrastructure needs and is maintained in a state of good repair.
23	Fleets and infrastructure should be permanently modified or seasonally winterized to address known vulnerabilities and maximize storm preparedness.
24	Fleets that are most vulnerable to storm conditions should be substituted out of operation during storms.
25	Uninterrupted capital investment should be maintained to ensure the storm preparedness of the MTA fleet and infrastructure.

Appendix B – Agency action plans

B1.   MTA Headquarters

Operations actions		Status	Due
O1	*Recommendation 1:* Create an MTA Emergency Coordinator position to facilitate coordinated MTA-wide storm operations and review storm preparedness on an ongoing basis.	Completed	
O2	*Recommendation 5:* Identify opportunities for coordinating City or municipal resources to help in clearing bus stops, sidewalks leading to stations, etc.	Ongoing	Q3 2011

Customer communications actions		Status	Due
C1	*Recommendation 10:* Coordinate external communications to advise that travel may be disrupted and service curtailments or modifications may be necessary during severe storms.	Ongoing	Q3 2011
C2	*Recommendation 11:* Develop processes to expedite the posting of service updates and other content to the *mta.info* web site.	Completed	
C3	*Recommendation 11:* Post links to other area transportation agency web sites (e.g. NJ Transit) on the *mta.info* web site weather page.		Q3 2011
C4	*Recommendation 12:* Develop improved coordination with 311 and 911 including: • Protocols for providing 311 with service status updates and alternative transportation options; • Protocols enabling 311 and 911 to direct MTA service inquiries to the appropriate MTA communication channels; • Protocols enabling the MTA to track MTA-related 311 and 911 complaints during storms and other significant operating events.	Completed	

		Status	Due
C5	*Recommendation 12:* Develop processes for sharing service status information with third-party mobile application and web developers.	Ongoing	Q3 2011
C6	*Recommendation 12:* Develop an integrated solution for transmitting customer messages via multiple channels (e.g., web site, e-mail, Twitter.)	Ongoing	Q3 2011
C7	*Recommendation 12:* Develop procedure for monitoring social media to ascertain real-time customer feedback during a storm event.	Ongoing	Q3 2011
C8	*Recommendation 13:* Increase capacity of the *mta.info* web site infrastructure to serve the elevated customer demand experienced during storms.	Upgrade completed; will be monitored on an ongoing basis	

Equipment actions		Status	Due
E1	*Recommendation 25:* Work with funding partners to secure Capital Program funding for 2012-2014.	Ongoing	As req'd

B2.   NYCT Subway

Operations actions		Status	Due
O1	*Recommendations 2, 3, 4, 5, 6:* Complete development of enhanced winter manual including: • New Plan V severe storm alert level with procedures for controlled service curtailment; • Guidelines for when to declare alert level relative to forecasted storm arrival; • Improved allocation of resources to protect critical infrastructure (e.g., 38th St Yard Lead); • Protocols for using work trains and snow-fighting equipment to transport staff around the subway network.	Ongoing	Q3 2011
O2	*Recommendation 2:* Develop procedures for minimizing accumulation of station refuse backlogs following storms.	Ongoing	Q3 2011

O3	*Recommendation 2:* Reorganize command and control structure to re-centralize operating responsibilities across entire subway network.	Completed	
O4	*Recommendation 3:* Introduce centralized Incident Command Center (ICC) for coordinated situation room management of storms and other significant operating events.	Completed	
O5	*Recommendation 7:* Review procedures for managing stuck train events in context of prolonged stranding of A train at Aqueduct Racetrack station.	Ongoing	Q3 2011
O6	*Recommendation 7:* Develop procedures for assigning a senior level manager as a customer advocate in the ICC.	Completed	
O7	*Recommendation 9:* Conduct "table top" exercises to practice storm management using the new Incident Command Center (ICC), post-reorganization command structure, and improved customer advocacy procedures.	Completed; exercises will be carried out on an ongoing basis	

Customer communications actions		Status	Due
C1	*Recommendations 11, 12, 14:* Develop protocol for concentrating customer communications staffing at the Rail Control Center (RCC) during storm events.	Ongoing	Q3 2011
C2	*Recommendation 12:* Develop an integrated solution for transmitting customer messages via multiple channels (e.g., web site, e-mail, Twitter.)	Ongoing	Q3 2011
C3	*Recommendation 12:* Introduce cell phone coverage on subway platforms.	Ongoing	Initial roll-out Q3 2011
C4	*Recommendation 14:* Review effectiveness of automated service status reporting systems (e.g., next train arrival signs) during prolonged service interruptions.	Ongoing	Q3 2011
C5	*Recommendation 14:* Expand inventory of customer information displays in stations.	Ongoing	Q3 2011

C6	*Recommendation 14:* Develop protocols for improving use of station staff, public address system, and station display screens for proactively communicating service status to customers in stations during storm events.	Ongoing	Q3 2011

Staffing actions		Status	Due
S1	*Recommendations 15, 16, 18:* Identify, evaluate, and implement where appropriate options for increasing staff availability or securing other resources to enable more rapid clearing and recovery of infrastructure.	Ongoing	Q3 2011
S2	*Recommendation 15:* Implement proposed mass-call system to facilitate rapid mobilization of hourly staff.	Ongoing	Q1 2012
S3	*Recommendation 15:* Eliminate stations labor agreement clauses that stipulate minimum snowfall thresholds for declaring a state of emergency.	Ongoing	Q3 2011
S4	*Recommendation 17:* Develop procedures for mobilizing administrative staff in support roles during severe storms (may be part of Plan V.)	Ongoing	Q3 2011
S5	*Recommendation 19:* Review transportation staff training curriculum and incorporate crisis management techniques (e.g., managing customers on stuck trains.)	Ongoing	Q3 2011

Equipment actions		Status	Due
E1	*Recommendations 21, 25:* Implement New Technology signals project to provide Rail Control Center (RCC) with indications of B-division train locations.	Ongoing	Q2 2012
E2	*Recommendation 21:* Mount video cameras with wireless link on diesel locomotives to provide management with remote view of infrastructure conditions.	Ongoing	Q3 2011
E3	*Recommendations 22, 25:* Complete procurement of eight new snow throwers.	Ongoing	Q3 2011

E4	*Recommendations 22, 25:* Develop proposal for upgrading life-expired jet blowers.	Ongoing	Q3 2011
E5	*Recommendation 22:* Complete in-house retrofit of B-division deicing cars.	Ongoing; design complete	Q3 2011
E6	*Recommendation 22:* Pilot use of electric snow blowers for clearing station platforms.	Ongoing	Q3 2011
E7	*Recommendations 23, 25:* Expand installation and remote monitoring of infrastructure heaters (e.g., third rail, switches, stop arms.)	Ongoing	Q3 2011
E8	*Recommendation 23:* Revise AC traction control software on New Technology fleets to improve tolerance for poor third rail contact, preventing immobilization.	Ongoing	Q3 2011

B3.   Regional Bus

Operations actions		Status	Due
O1	*Recommendations 2, 3, 4, 5, 6:* Complete development of enhanced winter manual including: • Alert levels aligned to prospective storm conditions; • Procedures for controlled service curtailment; • Provision for different levels of response in different areas of the bus network; • Guidelines for when to declare alert level relative to forecasted storm arrival.	Ongoing	Q3 2011
O2	*Recommendations 2, 20:* Develop a strategy for providing radio communications in the context of shortcomings of the existing radio system, including procedures to follow in the event of a radio system failure.	Ongoing	Q3 2011
O3	*Recommendations 2, 21:* Test operational uses of GPS tracking as this capability becomes available via Bus Time.	Ongoing	Q1 2012
O4	*Recommendation 2:* Combine the resources of the Brooklyn and Queens satellite desks to improve management of storm operations.	Completed	

O5	*Recommendation 3:* Introduce centralized situation room for coordinated management of storms and other significant operating events.	Completed	
O6	*Recommendation 4:* Develop procedures for pre-staging tow trucks throughout the network prior to the onset of a storm.	Completed	
O7	*Recommendation 5:* Develop and agree to a revised set of priority plowing routes with Sanitation, to ensure that bus routes are prioritized. Also develop protocols for sharing real-time plowing information.	Ongoing; priority routes to be included in the Winter Operations update	Q3 2011
O8	*Recommendation 5:* Establish direct communications with CEMUSA to ensure coordination of snow clearing from bus shelters.	Ongoing	Q3 2011
O9	*Recommendation 6, 10:* Investigate developing curtailed "snow routes" that can be operated in severe storms.	Ongoing	Q3 2011
O 10	*Recommendation 7:* Develop Snow Desk application to automate the process of monitoring stuck buses.	Ongoing	Q3 2011
O 11	*Recommendation 7:* Develop procedures for assigning a senior level manager in the situation room to advocate for stuck customers.	Completed	

Customer communications actions		Status	Due
C1	*Recommendation 10* Develop outreach for proactively communicating potential service curtailments or "snow routes" to customers.	Ongoing	Q3 2011
C2	*Recommendations 11, 12:* Centralize internal service status reporting and recording of event chronology to facilitate organized service updates to customers and external stakeholders.	Completed	
C3	*Recommendations 11, 12:* Develop processes for improving real-time service status information, including route-level service diversion information.	Ongoing	Q3 2011
C4	*Recommendation 12:* Develop an integrated solution for transmitting customer messages via multiple channels (e.g., web site, e-mail, Twitter.)	Ongoing	Q3 2011

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Staffing actions		Status	Due
S1	*Recommendations 15, 16, 18:* Establish protocols to minimize exposure to staffing shortfalls during vacation periods and coordinate additional help from depots and support departments as required.	Completed	
S2	*Recommendation 15:* Evaluate opportunities for creating an "emergency" condition that would enable management to call in hourly employees outside of normal shifts.	Ongoing; must be evaluated by labor relations	Q3 2011
S3	*Recommendation 17:* Develop procedures for mobilizing administrative staff in support roles during severe storms.	Ongoing	Q3 2011
S4	*Recommendation 19:* Review and improve driver training curriculum on winter driving practices (especially for articulated buses.)	Ongoing; will launch winter driving training and information campaigns preceding next winter	Q3 2011
S5	*Recommendation 19:* Review transportation staff training curriculum and incorporate crisis management techniques (e.g., managing customers on stuck buses.)	Ongoing	Q3 2011

Equipment actions		Status	Due
E1	*Recommendations 21, 25:* Install GPS tracking across entire bus fleet.	Ongoing; Bus Time pilot on B63 route, to be expanded to bus routes across Staten Island	Q4 2011 for all Staten Island
E2	*Recommendation 22, 25:* Reassess snow-fighting equipment and upgrade capability as required.	Ongoing	Q3 2011
E3	*Recommendation 23:* Update procedures for installation and use of bus tire snow chains, to minimize disruption to depot operations and prevent damage to buses.	Ongoing	Q3 2011
E4	*Recommendation 23:* Develop actions for improving fleet storm readiness based upon investigations into year-round use of snow tires, sanders for low-floor buses, and traction control disengagement to unstick buses.	Ongoing	Q3 2011

		Completed	
E5	*Recommendation 24:* Develop protocols for substituting 40-foot buses for articulated buses during storm operations.	Completed	

B4.   Long Island Rail Road

Operations actions		Status	Due
O1	*Recommendation 2:* Update and expand winter storm protocols to improve documentation of storm events and promote accountability.	Ongoing	Q3 2011
O2	*Recommendation 2:* Implement revised storm operating procedures to reduce the number of switches at Jamaica that must be cleared during storms.	Ongoing	Q3 2011
O3	*Recommendations 2:* Develop improved procedures for concentrating resources on clearing switches, yards and other vulnerable infrastructure.	Completed	
O4	*Recommendations 2, 24:* Review diesel-only storm operations to streamline logistics of reconfiguring trains and prevent service recovery bottlenecks.	Completed	
O5	*Recommendation 2:* Introduce policy for charging off-peak fares during reduced-service storm operations.	Completed	
O6	*Recommendation 8:* Develop improved strategy for operating reduced-service schedules during storms and subsequent recovery periods.	Completed	

Customer communications actions		Status	Due
C1	*Recommendations 10, 11,12, 14:* Improve procedures for proactively informing customers about train storm service schedules and status before and during storms.	Ongoing	Q3 2011

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C2	*Recommendations 11, 12:* Develop procedures for providing customer information on station parking lot plowing status.	Ongoing	Q3 2011
C3	*Recommendation 12:* Launch "know before you go" campaign encouraging customers to sign up for e-mail alerts.	Completed	
C4	*Recommendation 14:* Complete station customer information (AVPS) upgrades to enable faster updates of special train service schedules.	Completed	

Staffing actions		Status	Due
S1	*Recommendations 15, 16, 18:* Identify, evaluate, and implement when appropriate, options for increasing staff availability or securing other resources to enable more rapid clearing and recovery of infrastructure.	Ongoing	Q3 2011
S2	*Recommendation 15:* Re-introduce mass-call system to facilitate rapid mobilization of hourly staff.	Ongoing	Q4 2012
S3	*Recommendation 16:* Qualify station cleaners in Road Worker Protection procedures to enable them to clear snow from station platforms.	Completed	
S4	*Recommendation 16:* Qualify more staff to operate snow-fighting equipment.	Completed	

Equipment actions		Status	Due
E1	*Recommendation 21:* Evaluate benefits of deploying train fleet-wide GPS tracking and develop deployment strategy if appropriate.	Ongoing	Q3 2011
E2	*Recommendation 22:* Acquire plow and spreader equipment for clearing snow from tracks.	Ongoing	Q3 2011
E3	*Recommendation 22:* Upgrade jet snow blower equipment.	Ongoing	Q3 2011
E4	*Recommendation 23:* Complete modifications to diesel fleet to prevent snow ingestion.	Ongoing	Q3 2011

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E5	*Recommendation 23:* Update fleet winterization procedures to capture new processes and ensure completeness.	Ongoing	Q3 2011
E6	*Recommendation 23:* Install snow fences at known snow drift problem locations.	Ongoing	Q3 2011

B5.   Metro-North Railroad

Operations actions		Status	Due
O1	*Recommendation 2:* Review and update storm procedure checklist.	Completed	
O2	*Recommendation 2:* Develop procedures for proactively preparing and operating longer trains to maximize capacity under reduced-service schedules.	Completed	
O3	*Recommendation 2:* Develop processes for monitoring train crowding and adding service as required to meet demand under reduced-service schedules.	Completed	
O4	*Recommendation 2:* Update procedures for operating patrol trains (without customers) to help clear tracks and monitor infrastructure conditions.	Completed	
O5	*Recommendation 3:* Improve procedures for compiling information received overnight in the situation room for effective use the following morning.	Completed	
O6	*Recommendation 4:* Develop procedures for pre-staging snow-fighting equipment at strategic locations in the network prior to the onset of a storm.	Completed	
O7	*Recommendations 4, 24:* Develop procedures for proactively positioning diesel trains to operate first morning services during storms.	Completed	

O8	*Recommendation 7:* Develop formalized procedures for managing stuck trains and stranded customers.	Completed	
O9	*Recommendation 7:* Develop procedures for assigning a senior level manager as a customer advocate in the situation room.	Completed	
O 10	*Recommendation 8:* Develop improved strategy for operating reduced-service schedules during storms and subsequent recovery periods.	Ongoing	Q4 2011

Customer communications actions	Status	Due
C1	*Recommendations 11,12, 14:* Improve coordination of real-time service information via new Customer Communications Center.	Ongoing	July 2011
C2	*Recommendation 12:* Develop an integrated solution for transmitting customer messages via multiple channels (e.g., web site, e-mail, Twitter.)	Ongoing	Q4 2011
C3	*Recommendations 1, 14:* Coordinate with NYCT to provide subway service status information at Grand Central Terminal and other key stations	Ongoing; first displays have been installed at GCT	Q4 2011
C4	*Recommendations 14, 25:* Complete upgrades to public address system at outlying stations to increase capacity for service update announcements.	Ongoing	Q1 2012

Staffing actions	Status	Due
S1	*Recommendations 15, 16, 18:* Identify, evaluate, and implement when appropriate, options for increasing signals staff availability to enable more rapid clearing and recovery of signal infrastructure.	Ongoing	Q4 2011

Equipment actions		Status	Due
E1	*Recommendation 21:* Evaluate benefits of deploying support vehicle fleet GPS tracking and develop deployment strategy if appropriate.	Ongoing; review underway	Q3 2011
E2	*Recommendation 21, 25:* Provide live video feeds from key station platforms and other infrastructure to the situation room.	Ongoing; further progress pending capital funding	Q4 2011
E3	*Recommendation 22:* Reassess snow-fighting equipment and upgrade capability as required.	Ongoing; requisitions for new equipment issued	Nov 2011
E4	*Recommendations 24, 25:* Continue to accept and put into service new M8 trains to reduce dependency on legacy M2, M4 and M6 fleets that are vulnerable in storm conditions. * Date when sufficient number of M8 cars will be in service to mitigate winter weather impacts on New Haven Line service	Ongoing	Q4 2013*

B6. Paratransit

Operations actions		Status	Due
O1	*Recommendations 1, 2:* Develop protocols for exchanging status updates with Buses concerning street plowing conditions.	Ongoing	Oct 2011
O2	*Recommendations 2, 5, 7:* Develop a dashboard storm monitoring system to track stranded vehicles and customers, OEM notifications, and trip cancellations on a half-hourly basis.	Completed	
O3	*Recommendations 2, 6:* Develop new paratransit-specific Storm Action Plan including processes for curtailing all non-medically essential service.	Ongoing	Oct 2011
O4	*Recommendation 2:* Develop procedures for cancelling all paratransit eligibility assessments and appeal hearings during a storm event.	Completed	

O5	*Recommendation 2:* Implement one-day-only advance trip booking prior to forecasted storms.	Completed	
O6	*Recommendation 2:* Introduce policy for suspending penalties for no shows or late cancellations during storm events.	Completed	
O7	*Recommendation 2:* Develop procedures for deploying extra unassigned vans to enhance Command Center ability to maintain service during storm events.	Completed	
O8	*Recommendation 2:* Develop procedures for staffing the Command Center on 12-hour shifts to increase coverage during storms.	Completed	
O9	*Recommendation 2:* Develop protocols for carriers to communicate impassible street conditions to Command Center.	Completed	
O 10	*Recommendations 5, 7:* Coordinate with OEM and City Agencies to develop rescue procedures for customers who are stuck or develop medical needs during storms.	Ongoing	Oct 2011
O 11	*Recommendation 7:* Develop protocols for communicating stranded customer updates to Buses Command Center.	Completed	

Customer communications actions		Status	Due
C1	*Recommendations 10,12:* Launch Interactive Voice Response (IVR) customer calling system to aid in communicating service suspensions.	Ongoing	Oct 2011
C2	*Recommendation 12:* Develop proposals for launching new customer communications channels, such as e-mail.	Ongoing; part of second phase of IVR	Oct 2012
C3	*Recommendation 12:* Work with media outlets to ensure that service status is communicated in a way that avoids confusion over paratransit in NY and NJ.	Ongoing	Oct 2011

Equipment actions		Status	Due
E1	*Recommendations 23, 25:* Replace life-expired supervisor vehicles with 4-wheel drive vehicles to enable field supervisors to operate in inclement road conditions.	Ongoing; constrained by end of life requirements on existing fleet	Mar 2012
E2	*Recommendation 23:* Purchase tire snow chains to fit 10% of the paratransit fleet.	Completed	
E3	*Recommendation 24:* Develop protocols for only deploying vans (which handle better in snow than sedans) during storm operations.	Completed	

B7.   Bridges and Tunnels

Operations actions		Status	Due
O1	*Recommendation 2:* Update storm management procedures to address general snow event preparations, outline snow event operations by level type, and include a post event operations recovery plan and after action review.	Completed	
O2	*Recommendation 2:* Develop formalized procedure for posting dedicated Technology Department staff prior to the beginning of Level 3 storm events.	Completed	

Staffing actions		Status	Due
S1	*Recommendation 18:* Incorporate line items in future engineering contracts, requiring contractors to provide snow removal assistance during severe storms.	Ongoing	First contract in Q3 2011

Equipment actions		Status	Due
E1	*Recommendations 1, 24:* Develop formalized procedure for providing snow-fighting equipment or other assistance to other MTA Agencies during storms or other significant operating events.	Completed	

Appendix C – Peer transportation systems

Ten transportation systems from around the world provided feedback for this report. The MTA thanks these peers for their valued participation and looks forward to sharing this report and its findings.

Location	System
Berlin, Germany	Berliner Verkehrsbetriebe (BVG) (Berlin Transportation Company)
Boston, USA	Massachusetts Bay Transportation Authority (MBTA)
Eastern Japan	East Japan Railway Company (JR East)
Helsinki, Finland	Helsingin Kaupungin Liikennelaitos (HKL) (Helsinki City Transport)
Montreal, Canada	Société de transport de Montréal (STM) (Montreal Transport)
Oslo, Norway	Oslo T-banedrift AS, operator of Oslo Tunnelbane (Oslo Metro)
Pittsburgh, USA	Pittsburgh Port Authority
Switzerland	Schweizerische Bundesbahnen (SBB) (Swiss Federal Railways)
Toronto, Canada	Toronto Transit Commission (TTC)
Vienna, Austria	Wiener Linien (Vienna Lines)