Identification of Communication and Coordination Issues in the U. S. Air Traffic Control System

by

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Abstract

Today's air traffic control system is approaching the point of saturation, as evidenced by increasing delays across the National Airspace System (NAS). There exists an opportunity to enhance NAS efficiency and reduce delays by improving strategic communication throughout the ATC system. Although several measures have been taken to improve communication (e.g., Collaborative Decision Making tools), communication issues between ATC facilities remain. It is hypothesized that by identifying the key issues plaguing inter-facility strategic communication, steps can be taken to enhance these communications, and therefore ATC system efficiency.

In this thesis, a series of site visits were performed at Boston and New York ATC facilities as well as at the Air Traffic Control System Command Center. The results from these site visits were used to determine the current communication and coordination structure of Traffic Management Coordinators, who hold a pivotal role in inter-facility communications. Several themes emerged from the study, including: ambiguity of organizational structure in the current ATC system, awkward coordination between ATC facilities, information flow issues, organizational culture issues, and negotiation behaviors used to cope with organizational culture issues.

Acknowledgements

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Tables and Figures

Abbreviations

A90	Facility identification for Boston TRACON
APREQ	Approval/Request program in New York
ARTCC	Air Route Traffic Control Center
ATA	Air Transportation Association
ATC	Air traffic control
ATCSCC	Air Traffic Control System Command Center
AVN 50	Flight Check Group
BOS	Facility identification for Boston Tower
CARF	Central Altitude Reservation Function
CCFP	Collaborative Convective Forecast Planner
CDM	Collaborative Decision Making
DSP	Departure Sequencing Planner
EDCT	Estimated Departure Clearance Time
ETMS	Enhanced Traffic Management System
EWR	Facility identification for Newark Tower
FAA	Federal Aviation Administration
FDIO	Flight Data Information Operation
FSM	Flight Schedule Monitor
GI	General Information
GDP	Ground Delay Program
IAD	Facility identification for Washington Dulles Tower
ICAO	International Civil Aviation Organization
IDS	Information Display System
ITWS	Integrated Terminal Weather System
JFK	Facility identification for John F. Kennedy Airport Tower
LGA	Facility identification for La Guardia Tower
MHT	Facility identification for Manchester facility
MIT	Miles In Trail

N90	Facility identification for New York TRACON
NAS	National Airpsace System
NATCA	National Air Traffic Controllers Association
NOTAM	Notices to Airmen
NMCC	National Maintenance Coordination Center
OACC	Oceanic Area Control Center
OIS	Operations Information System
PVD	Facility identification for Providence Tower
SID	Standard Instrument Departure
TCAP	Traffic Count Automation Program
TEB	Facility identification for Teterboro Tower
TMC	Traffic Management Coordinator
TMO	Traffic Management Officer
TMS	Traffic Management Specialist
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control
TSD	Traffic Situation Display
VHF	Very High Frequency
ZAB	Facility identification for Albuquerque Center
ZAU	Facility identification for Chicago Center
ZBW	Facility identification for Boston Center
ZDC	Facility identification for Washington Center
ZDV	Facility identification for Denver Center
ZFW	Facility identification for Dallas-Fort Worth Center
ZHU	Facility identification for Houston Center
ZID	Facility identification for Indianapolis Center
ZJX	Facility identification for Jacksonville Center
ZKC	Facility identification for Kansas City Center
ZLA	Facility identification for Los Angeles Center
ZLC	Facility identification for Salt Lake City Center
ZMA	Facility identification for Miami Center

ZME	Facility identification for Memphis Center
ZMP	Facility identification for Minneapolis Center
ZNY	Facility identification for New York Center
ZOA	Facility identification for Oakland Center
ZOB	Facility identification for Cleveland Center
ZSE	Facility identification for Seattle Center
ZTL	Facility identification for Atlanta Center

Chapter 1

Introduction

By improving strategic communication and coordination within the air traffic control (ATC) system, it is thought that air traffic delays could be reduced and system efficiency could be enhanced. This thesis examines the current communication structure from the perspective of the air traffic controllers who perform this inter-facility strategic communication and coordination. Based on the examination of the communication structure and perceived problems in the coordination practices used today, insights into improving strategic communication and coordination are suggested and discussed.

The U. S. Air Traffic Control system is quickly reaching a crisis state as we begin the new millennium. In the first nine months of 2000, one in four aircraft in the National Airspace System (NAS) found itself plagued by system delays averaging 50 minutes per aircraft and affecting 119 million people (Greenberg, 2001). Figure 1.1 depicts the air traffic situation in the continental U. S. during an afternoon in May, 2001. As can be seen from the picture, the ATC system is under heavy demand, particularly along the east coast. This demand has grown steadily the past few decades. For example, air carrier departures in 1999 rose 12% over departures logged in 1994. (FAA 2001) Air traffic has grown more than 2.5 times since 1974.

Unfortunately, the airport infrastructure has failed to keep pace with this growing air traffic demand. Due to environmental concerns and land availability in the metropolitan areas, airport construction will likely continue to progress slowly. Before Denver International Airport was opened in 1995, the last major U.S. airport to be built was Dallas/Fort Worth airport in 1974. (Dempsey, 1997)

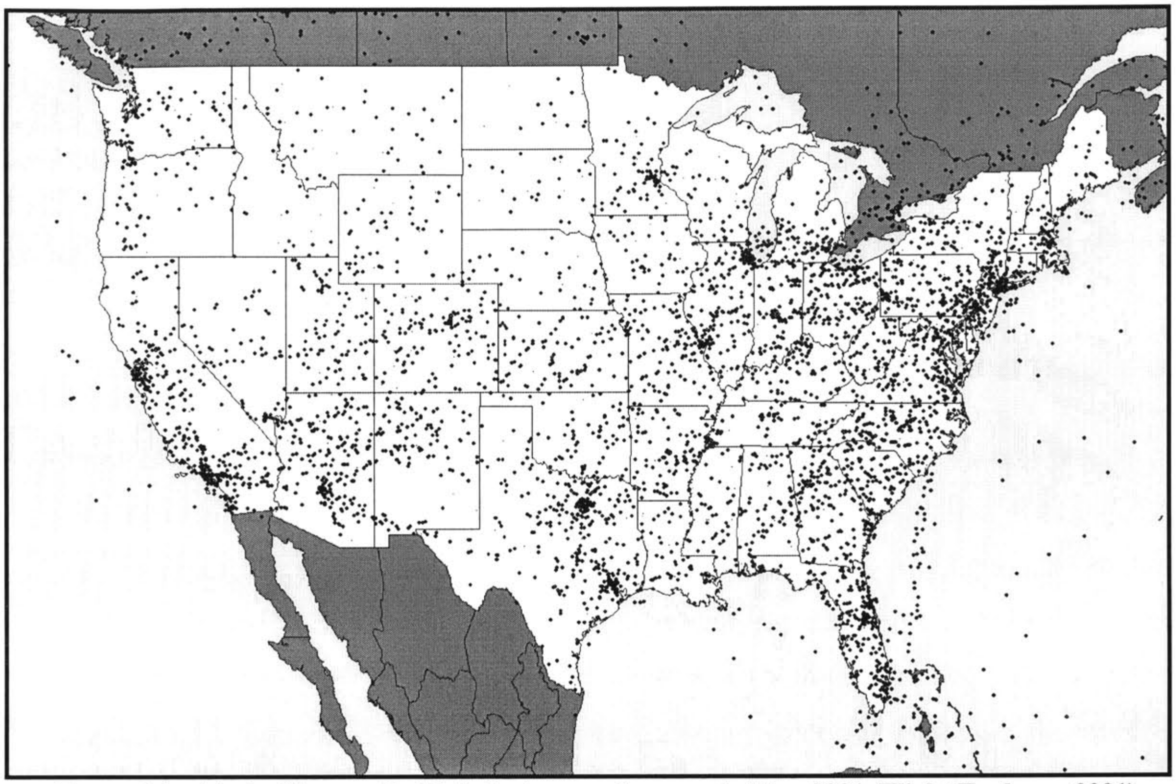

Figure 1.1: Air traffic over the U. S. during an afternoon in May 2001 (Flight Explorer, 2001).

Congress has taken note of the situation facing American travelers and called Federal Aviation Administration (FAA) executives, airline CEOs, and representatives from the National Air Traffic Controllers Association (NATCA) to speak on the problems in front of a House panel (Mann, 2001). Among the promises that the airline industry and the FAA made to the House officials was a pledge to document the precise cause of delays. Only then can these problems be researched and possibly remedied.

One area that could enhance the effort to reduce delays is to increase the efficiency of strategic communications and coordination within the air traffic control system. Because strategic communication and coordination has been recognized as a critical area in which to improve system efficiency, an effort to improve communications among ATC facilities and the airlines was developed called Collaborative Decision Making (CDM). Much of this effort has culminated in traffic management tools whose goal is to increase information sharing between the parties while reducing the coordination effort. For example, the Collaborative Convective Forecast Product (CCFP) affords a compilation of weather forecasts from ATC facilities and airlines. The CCFP's purpose was to offer airline and ATC meteorologists a way to pool information so that discussions over future weather behavior could be based on a single set of shared information, provided by the CCFP.

Little research has focused specifically on CDM issues, however. Smith and his colleagues (1997, 1999) are one of few groups that have performed field studies to investigate the benefits of CDM processes. In one study, they presented a series of scenarios laying out a situation in which an aircraft flew either an unsafe or an inefficient route. The aircraft's routing decisions stemmed either from miscommunication between ATC, the flight crew, and/or the airline, or from the fact that one party was lacking a critical piece of information. These scenarios were then discussed among a group of professional controllers, Command Center specialists, airline dispatchers and pilots. Suggestions were made by the group to prevent the undesirable situation from happening in the future. In this study, Smith et al. found that the different parties needed to develop a realistic view of the "capabilities and viewpoints of others within the system", and that there is a need for "more effective communication and information exchange". In addition, they suggested that there is a potential for increasing the collaborative decision making in strategic communication.

The CDM tools that have been dispensed into the air traffic control system have been effective at improving communications between ATC and the airlines. It is now important to further the effectiveness of the CDM initiatives by investigating how it can be applied internally within the ATC system, specifically in inter-facility ATC communications. The Command Center facility, the Air Route Traffic Control Center ("Center") facilities, the Terminal Radar Approach Control (TRACON) facilities, and the Tower facilities must be able to communicate smoothly to ensure an efficient operation. To examine how CDM can be implemented at the inter-facility level of ATC communications, the ATC position of Traffic Management Coordinator must be considered. Throughout the rest of this chapter, the position of the TMC will be discussed and the factors that influence the effectiveness of this position's communications will be introduced.

1.1 ATC System Structure and the Traffic Management Coordinator

The current U. S. Air Traffic Control System contains four different types of air traffic control facilities. Monitoring the entire National Airspace System (NAS) is the Air Traffic Control System Command Center (ATCSCC or "Command Center"). This facility is responsible for maintaining efficiency across the U. S. by communicating with the airlines and the ATC facilities. These communications determine the programs that should be implemented to maintain the maximum national throughput without unfairly delaying groups of aircraft. The Command Center is exclusively a flow control facility—it does not have direct contact with the individual aircraft.

The U. S. is then split into 20 Air Route Traffic Control Centers (ARTCCs or "Centers") that are the largest ATC facilities who interact directly with the aircraft. These Centers are responsible for the safety and efficiency over their assigned area of the airspace. Controllers at the Centers communicate with individual aircraft that are generally at high altitudes and/or away from major airports. The Terminal Radar Approach Control (TRACON) facilities house controllers that are responsible for the airspace within approximately 40 miles of major airports. Towers are responsible for approaches and departures of aircraft as well as taxiing at a specific airport.

Figure 1.2 is a schematic of the current communication that occurs between the ATC facilities as well as with the airlines. In the figure, inter-facility communication is broken up into local and national communications. National communication is communication involving the Command Center, which generally addresses traffic management issues affecting multiple facilities. Local communication does not involve the Command Center and addresses traffic management for a single Center's airspace or adjacent Centers' airspaces. The ATC position that performs both local and national inter-facility communication is the Traffic Management Coordinator (TMC), located at each facility.

The TMC position in the ATC facility is responsible for coordinating traffic flows into, and out of, the facility through communications with other ATC facilities. The

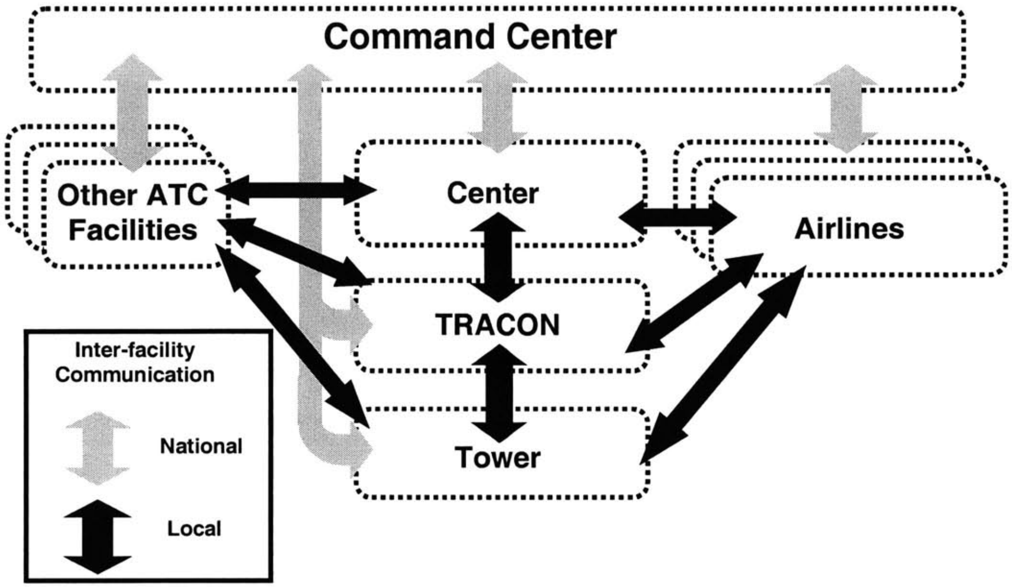

Figure 1.2: Current inter-facility communication among ATC facilities and airlines.

TMC is the most critical link between facilities in the system. While tactical controllers allow aircraft into the facility on a flight-by-flight basis, the TMCs control whether fixes and jet routes into and out of the facility are open and the rate at which traffic can flow through specific fixes. The TMCs are also responsible for monitoring operations within the facility, determining when the tactical controllers are overloaded with aircraft and responding. The TMCs communicate and negotiate with other facilities' TMCs to coordinate appropriate traffic initiatives to reduce demand into the facility. They are also responsible for communicating initiatives and restrictions to the tactical controllers in a timely manner.

Traffic initiatives are used by the TMCs as an organized means of reducing demand into one or multiple facilities. Two types of traffic initiatives can be implemented to prevent airspace from becoming overloaded—national or local traffic initiatives. Table 1, adapted from Idris (2000) provides a short list of the possible traffic initiatives normally available to facility TMCs. Often the TMCs address traffic overload first through local traffic initiatives such as Miles-In-Trail (MIT) or the Departure Sequencing Planner (DSP). These local initiatives are short-term traffic solutions that are

Program	Effect	Time Window	Penalty	Downstream	Origin	Directed Towards	Time Scale
MIT/MINIT (Miles/Minutes in trail)	Spacing	None	Transfer task to next sector	Sector	ARTCC (Center)	Other Centers or TRACONs	Short term
					TRACONs	Centers	
DSP (Departure Sequencing Planner)	Wheels off time	0, +3	Call back	Sector	ARTCC (Center)	Originating airport	Short term
GDP (Ground Delay Program)	EDCT (Expected Departure Clearance Time)	-5, +10	Call back	Destination airport	ATCSCC (Command Center)	Originating airport	Long term
GDP (Ground Delay Program)	Clearance time (Time delay)	None	None	Destination airport	ATCSCC (Command center)	Originating airport	Long term
GS (Ground Stop)	Delay until further notice	None	None	Destination airport	ATCSCC (Command Center)	Originating airport	Short term

Local initiatives (dark shading) **National initiatives** (light shading)

Table 1: Local and national ATC traffic programs (Idris, 2000).

often implemented by Tower, TRACON, or Center facilities. MIT restrictions require the upstream facility to maintain a certain minimum number of miles between each aircraft entering the restricted facility.

If the traffic demand is predicted to be high for longer periods of time, the facility TMCs will coordinate with the Command Center to implement a national traffic initiative such as a Ground Delay Program (GDP). Ground Delay Programs are implemented to curb arrival flows into an overloaded airport. To do this, Estimated Departure Clearance Times (EDCTs) are assigned to aircraft at other airports departing to the restricted airport. The EDCT is generally a fifteen-minute window in which the aircraft can depart. If this time is not met, the Tower facility must telephone the Command Center for a new EDCT. To coordinate both local and national traffic initiatives, a great deal of strategic communication must occur between facilities.

Because the TMCs hold such a critical position in the operations of today's ATC system, it is important to understand the strengths and weaknesses of the current inter-facility communication and coordination system between them and how this system can be enhanced.

1.2 Attributes of Multi-person Communication

In the previous section, communication was established as a critical factor in strategic operations within the ATC system. To better understand what makes for successful communications, this section discusses those factors that contribute to efficient communications. Communication is defined as the transfer of information between a sender and a receiver (French, Kast, & Rosenzweig, 1985). At any point between the sender and receiver, distortion and filtering can occur, often changing the original intent of the message. Distortion occurs when the original intent of the message is altered to reflect a different meaning. Filtering occurs when elements of the message are lost, changing the original intent of the message.

There are several attributes that must be present to send an effective message, and they are depicted schematically in Figure 1.3. *Completeness* is the first attribute of an effective message. If a message is missing a critical piece, then the original intent is not fully transmitted, and the message is incomplete. A second attribute is *accuracy*. If the full content of the message is communicated using the wrong vocabulary or notation (the message is poorly encoded), then the message's intent is lost. The message must also be sent in a *timely fashion*. If the message is sent too late, then the content of the message is lost, no matter how accurately it is transmitted.

Not only must the message be sent effectively, the message must also be decoded so that the original intent is understood by the receiver. People interpret messages based on what they want to hear—namely based on their beliefs and values. Past experiences both in interpreting other peoples' messages and interpreting the sender's messages are also used to decode. Past experience with the message context may also aid the receiver. (French et al., 1985)

Air traffic control has proved to be an interesting domain for communications research due to the importance that is placed on verbal communications between controller and pilot. In tactical communications between the controller and all of the

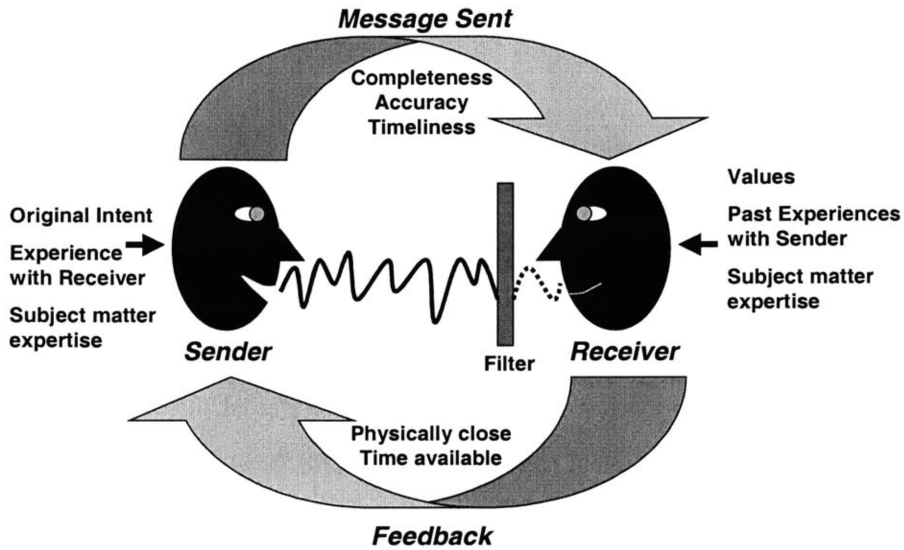

Figure 1.3: Distortion and filters preventing effective message transmission.

pilots within the controller's airspace, only a single VHF channel is available for communications. Due to the number of communications that must occur between the controller and the pilots and the poor quality of the communication channel, it is critical for the communications to exhibit a clear intent spoken expeditiously.

The safety-critical nature of verbal communications between controller and pilot has led the FAA & the International Civil Aviation Organization (ICAO) to hone the language to such an extent that, using the ICAO standard phraseology and timely feedback, there should be little question about the sender's true intent. This standard phraseology has also improved the speed with which the sender's intent can be communicated. This added speed decreases the controller's workload induced by communications tasks and allows the controller to handle more aircraft.

Communication is also important to the Traffic Management Coordinators within a facility. Though not directly influencing the safety of a particular aircraft, inadequate or misleading communications may lead dozens of aircraft along inefficient paths, as discussed in the study performed by Smith, et al. (1997). Several differences between tactical and strategic air traffic controller communication exist, making the strategic communication more complicated than tactical communications. One important difference in communications is the media used. Verbal communication in the Traffic Management Units can take the form of face-to-face conversation, telephone conversation, and teleconferences, all of which may require different ways of presenting or interpreting the information passed. In addition, verbal communication is supplemented by other communication media such as websites, e-mails, faxes, or shared erasable white boards.

Another difference is the number of people involved in strategic communications. There are often multiple people who need the information being sent, so communications must be widely distributed and unambiguous to all parties. Often, there is less time available for feedback, making the quality of the initial message very important. Several factors that influence the effectiveness of multi-person communication have been identified and are discussed in section 1.3.

1.3 Factors influencing the effectiveness of ATC communication

In multi-person communication, four factors have been identified by French et al. (1985) and Baron (1983) as major influences on the effectiveness of communication. Once identified, these factors will be used to evaluate the effectiveness of inter-facility communication in the current air traffic control system.

One factor influencing the effectiveness of communication is the organizational structure. A second factor is the physical environment in which communication occurs. Information flow between the communicating parties is considered a third factor. Finally, organizational culture will be addressed.

1.3.1 Organizational Structure

The structure of the organization plays a major role in determining how effective communications are between parties. The organizational structure dictates who can communicate with whom and implies authority within the system. There has been an extensive body of research investigating the effectiveness of different organizational structures. The two primary categories of organizational structure are centralized and decentralized structures.

Centralized communication networks are those in which one person communicates with each of the other parties. This centralized network has been found to be useful in solving simple problems quickly and accurately. Examples of centralized structures can be seen in a, b, and c in Figure 1.4.

The decentralized structures are networks in which there is no "lead" party, and each of the parties communicates with one another. Examples of a decentralized structure can be seen in d and e in Figure 1.4. This structure has been particularly good for solving difficult problems more slowly, but also more accurately than the centralized structure. Feedback is also more immediate and the decentralized structure is more conducive to "brainstorming" new and innovative ideas. (French et al., 1985) Parties in decentralized networks have also been found to be more satisfied than their counterparts in centralized networks, with the exception of the "lead" party. (Tubbs, 1988)

The ATC system structure has aspects of a hierarchical structure at the national level, in that the Command Center facility's responsibility is to maintain efficiency throughout the other three types of ATC facilities. In addition, most of the strategic traffic initiatives must be approved by the Command Center, and many of the strategic communications are coordinated by the Command Center. The centralized structure at the national level of ATC is depicted on the left of Figure 1.5. However, each ATC facility ultimately functions autonomously without being under the authority of the

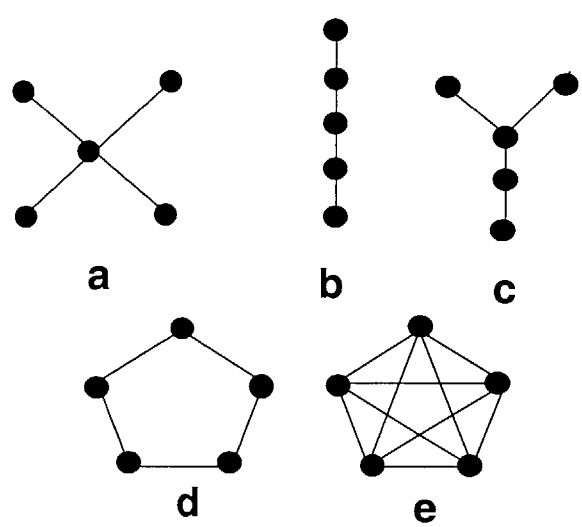

Figure 1.4: Centralized and decentralized 5-person organizational structures (Tubbs, 1988).

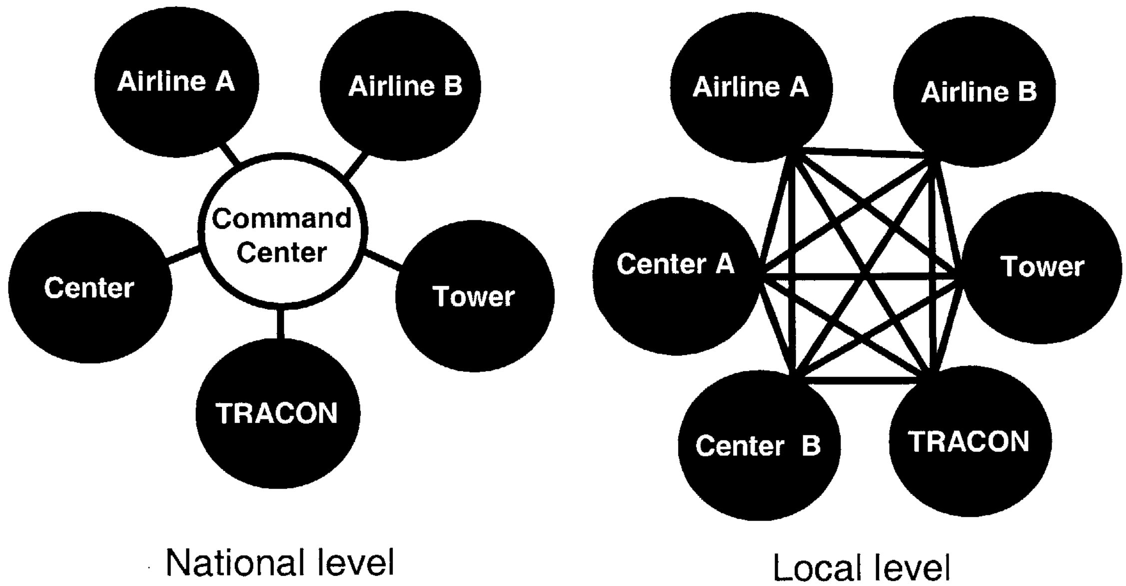

Figure 1.5: ATC organizational structure at the national level (centralized) and at the local level (decentralized).

Command Center, revealing a more decentralized structure at the local level. The more decentralized structure at the local level of the ATC system is depicted on the right side of Figure 1.5.

It is thought that this ambiguity of organizational structure in ATC will have an effect on the ATC strategic coordination. However, it is difficult to determine which organizational structure is most appropriate for the issues that the air traffic control system faces. While the integrated nature of the system demands one group to oversee the national flow issues, many of the issues require the ability of the Centers to settle the problems before they reach the Command Center level. This study will investigate the role of organizational structure in the ATC system and will attempt to identify signs of inadequate organizational structure. Inadequate organizational structure can have a negative effect on the daily communications and operations. Some consequences of inadequate structure are: 1) poor motivation and low morale, 2) poor decision making, 3) conflict and lack of coordination, and 4) failure to respond creatively to challenging circumstances (Child, 1977).

1.3.2 *Physical Environment*

Physical arrangement of people within an organization greatly influences the effectiveness of the communications that occur. Employees who are supposed to be able to communicate frequently should be located physically closer together. Baron (1983) states: "Studies have found that employees who work more than 25 feet apart on the same floor rarely have any significant communications." Implications of this study should be investigated for the air traffic control system, whose parties are required to be physically distant.

1.3.3 *Information Flow*

Another factor influencing the effectiveness of communication is the quality of information flow between the parties. French, et al. (1985) suggests that, as the operations within the organization become more complex, there must be a greater amount of information processing to support this decision-making under uncertainty. As discussed in the above sections, there are issues of distortion and omission of information in information flow in organizations. In addition, there are issues of information saturation and overload. (Baron, 1983)

Several measures can be taken to ensure that information and distortion are minimized. Information with a high degree of visual content can be communicated through easily-interpretable electronic media, such as websites or other information tools. Electronic communication eases the burden on the human who could have made mistakes or omitted information during the verbal re-construction of the information. A simple example of such information is current weather information available to air traffic controllers. A Doppler radar monitor is much more easily interpreted than a description by a meteorologist. Other examples of electronic information tools are presented in Appendix A.

Information that cannot be transmitted electronically, or would not be more effective in electronic form can be presented redundantly over multiple channels to ensure accuracy. Feedback about the communication can also be requested. A method of reducing distortion of messages sent through several parties is to send the information directly to the interested party. (Baron, 1983)

Once information is being transmitted redundantly or exhaustively to parties, the issue of information saturation and overload presents itself. Employees, particularly at the top of organizational hierarchies, find themselves saturated with information being provided from below. Methods of dealing with overload involve filtering the information, having a "gatekeeper" who filters the information for the employee, or queuing the information by presenting the highest-priority information first. The impact of information overload should be considered in the ATC system, especially for the Command Center Traffic Management Specialists (TMSs), who must integrate information from dozens of ATC facilities, airlines, and information tools to assess traffic management decisions.

Each of these information flow issues must be investigated in strategic communications. It is possible that some TMCs may be lacking certain information, while other TMCs are being overloaded with information. As was presented above, each case can be remedied through information re-distribution measures.

1.3.4 Organizational Culture

The final factor to be discussed is the influence that organizational culture has on communications. Training or experience in a position may have influenced how an employee communicates within the organization. Organizations that encourage good communication through managerial training may find that these positive communications skills trickle down to the operational levels. On the other hand, if the employees are presented with a manager who fails to communicate effectively, they may adopt the same behavior based on the idea that this manager is exhibiting the behavior needed to succeed in the organization. (Baron, 1983)

Organizational culture is an interesting area to investigate in strategic communications, because TMCs normally progress through the same structure of basic training as tactical controllers before achieving the TMC position. The effect of this training on their current communication practices will be explored further.

1.4 Communication Issues Addressed and Thesis Outline

This thesis addresses the need to study communication issues in air traffic control at the inter-facility level of strategic communication. The objective is to identify the current communication structures of the Traffic Management Coordinators at several facilities by determining who, why, through what means, and how often they communicate. This study will also identify the information tools used in the communication and coordination. Any problems that are perceived by the TMCs will be identified and possible enhancements will be suggested.

Chapter 1 of the thesis has provided an introduction air traffic control system structure, the importance of strategic communications and the communications issues to be addressed in this thesis. The methodology used to investigate issues in ATC inter-facility communication is discussed in Chapter 2. The results of field observations performed at Boston facilities are presented in Chapter 3. Chapter 4 provides the results from New York facilities, and Chapter 5 provides those from the Command Center. In Chapter 6, example cases of inter-facility information flow are presented. A discussion of the conclusions that can be drawn from the field studies is contained in Chapter 7. Chapter 8 contains a brief synopsis of the conclusions found from this study.

Chapter 2

Method

To investigate the current communication & coordination structure in inter-facility air traffic management, a series of site visits were performed to gather information from Traffic Management Coordinators at seven facilities.

2.1 Site Visit Protocol

Site visits were conducted at the facilities to both observe operations and perform focused interviews. The site visit began with a focused interview, and then branched into a period of observations, dictated by the tasks required of the TMC for that particular day.

2.1.1 Focused Interview

The site visit was initiated with a 30-minute focused interview of the position to determine the communication structure of that position and the traffic flow management initiatives that are used. An exhaustive list of the interview questions is presented in Table 2.1.

The communication structure was determined by posing a series of directed questions about the interviewee's daily communications. These questions sought to determine with whom the interviewee communicates, why and how often these communications occur, and through what mode these communications occur. Questions regarding the strengths and weaknesses of information tools as communications devices were also presented. The interviewee was questioned about whether problems existed in

Methods and Reasons for Current Communication Processes
Whom do you coordinate with throughout a shift during normal operations?
What modes of communication do you use to communicate with each of these people or groups?
Why do you coordinate with these people/groups?
How often do you coordinate with these people/groups?
Do you ever see the people with whom you coordinate? Do you know them by name?
What kind of relationship do you have with the people with whom you coordinate? Would you consider them "acquaintances" or "friends"?
What communications tools are available to your position?
What communications tools do you actually use? How often do you use them?
What are the strengths and weaknesses of these tools?
What are the communications problems that are present at the TMC position?
Can you suggest any improvements that could be made to communication/coordination in the TMC task?
Standard Traffic Management Procedures and Air Traffic Flow Dynamics
What are the circumstances in which the traffic flow would need to be altered?
What are the procedures, programs, and tools used to alter the flow?
Who makes the decision to implement them?
Who makes the decision to conclude them?
How are these modified over time to take the dynamics of the situation into consideration?
What are the problems with these programs? If they fail, why do they fail?
What are the bottlenecks in the system's ability to operate efficiently?
Can you tell me the procedure that you use when you determine that a traffic initiative is needed for your facility and how you go about implementing the traffic initiative?
What authority do the Traffic Management Coordinators have to redirect the flow? What are the constraints?
What information do the TMCs need to implement a traffic initiative?

Table 2.1: Questions used to conduct the focused interview.

the communications and/or coordination of the particular position and how communication/coordination could be improved.

The second part of the interview consisted of questions involving the traffic flow management programs that were available to the position. The interviewee was asked to provide a list of the traffic management procedures that were available to the position to control traffic flow and how these procedures were implemented and concluded.

The first three categories of the interviewee's results consisted of information gained from the focused interview. Using the responses from this focused interview, a

"Communication and Coordination Structure" was created. The interviewee was placed at the center within his or her respective facility and arrows were used to connect him or her to other positions with whom communication occurred on a normal basis. A list of perceived problems with the communication and coordination for that position was compiled as the second category, "Communication and Coordination Problems". The third category, "Suggestions for improved communication and coordination" resulted from a list of possible solutions provided by the interviewee to the problems listed previously.

2.1.2 Operational Observations

Once the focused interview was concluded, the site visit entered the observation period. During this period, the interviewee would return to the position and perform the position tasks. What was observed during this period depended on the time of day of the site visit, the weather on that day, and the traffic volume at the facility. During the mornings, the TMCs often participated in the daily teleconferences with separate ATC groups (e.g., New England facilities, East coast facilities, National teleconference). During severe weather, re-route procedures could be observed. Whenever a TMC was required to implement a traffic management initiative, that was also observed.

The information from this second portion of the site visit was compiled into an additional category of the results for the interviewee titled "Additional observations." The inter-facility communication and coordination examples in Chapter 7 also originate in information provided during the observation period.

2.2 Facilities observed

The facilities at which the site visits were performed were Boston Tower, Boston TRACON, Boston Center, Manchester Tower/TRACON, Newark Tower, New York TRACON, New York Center, and the Air Traffic Control System Command Center. The Boston facilities were chosen for logistical reasons and because they are representative of many facilities in the U.S. with a single major airport and several regional airports within the airspace. Manchester Tower/TRACON is a satellite airport near Boston, providing an inter-facility communication perspective from a small facility. The New York facilities were chosen because: 1) they are adjacent to the Boston facilities, providing opportunity to observe the bi-lateral communications between Boston and New York, 2) as a second set of facilities to evaluate if findings were generalizable to more than one facility or were facility-specific, and 3) New York is representative of a complex, multi-airport situation (i.e., Newark Airport, La Guardia Airport, JFK Airport, and Teterboro Airport). To address national coordination, an observation was performed at the Command Center.

A single site visit was conducted at Boston Tower, six site visits were conducted at Boston TRACON, and three site visits were conducted at Boston Center. One site visit was conducted at the Manchester facilities. In New York, two site visits were conducted at Newark Tower, two site visits were conducted at New York TRACON, and one site visit was conducted at New York Center. A single site visit to the Command Center in Herndon, Virginia was made.

2.3 Traffic Managers interviewed

Traffic Management Coordinators were interviewed because of their pivotal role in inter-facility communications. When available, the Traffic Management Officer (TMO) of the facility was also interviewed to obtain a managerial perspective on the issues. The TMO is the managerial head of the facility and represented the facility during daily teleconferences with the Command Center. Each position interviewed at Boston, New York, and the Command Center is listed below:

- Boston Center Traffic Management Officer
- Boston Center Traffic Management Coordinator
- Boston TRACON Traffic Management Officer
- Boston TRACON Traffic Management Coordinator
- Boston Tower Traffic Management Coordinator
- Manchester Facility Traffic Management Coordinator
- New York Center Traffic Management Coordinator
- New York TRACON Traffic Management Coordinator

- Newark Tower Traffic Management Coordinator
- Command Center West Supervisor
- Command Center Traffic Management Specialist

2.4 Analysis of Results from Site Visits

Once the site visits were completed and the results were compiled, an analysis was performed. A comprehensive list of all of the communications problems presented by the TMCs was created. Themes in the issues surrounding inter-facility communication and coordination problems and solutions emerged from this list. These themes are discussed in Chapter 8 as supported by the site visit data. Possible solutions suggested by the TMCs were then listed, and enhancements to inter-facility communications were proposed based on the TMC responses as well as on the emergent problems discussed previously.

Chapter 3

Results of Site Visits - Boston

The results of the site visits performed at Boston Center, Boston TRACON, Boston Tower, and the Manchester facility are presented below. Included in the results from each position is a detailed communication and coordination structure for that position, the information tools utilized, the problems that the position found in the communication and coordination associated with the position, and any other pertinent observations.

3.1 Boston Center (ZBW)

The Boston Center is located in Nashua, New Hampshire. Its airspace includes Maine, Vermont, New Hampshire, northeastern New York, Connecticut, and Rhode Island as well as some of the airspace on the eastern side of the trans-Atlantic routes. A graphical depiction of the Boston Center's airspace can be seen in Figure 3.1. The major airports inside Boston Center are Boston's Logan International Airport and Providence's T. F. Green Airport. There are also several satellite airports in the Boston vicinity to alleviate the pressure on the major airports. One of these is the Manchester, New Hampshire facility that will be discussed in Section 3.4.

Figure 3.2 represents the communication structure within the Boston Center. Individuals representing the Traffic Management Officer position and the Traffic Management Coordinator position were interviewed.

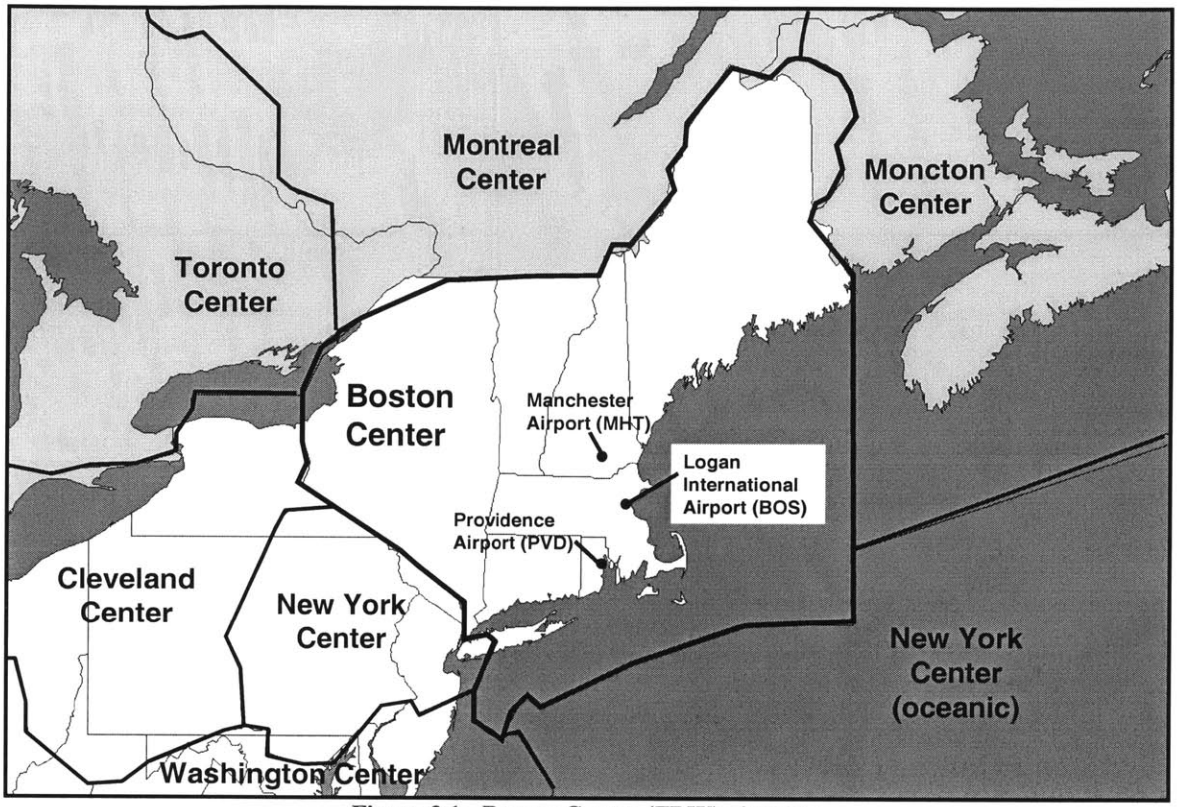

Figure 3.1: Boston Center (ZBW) airspace.

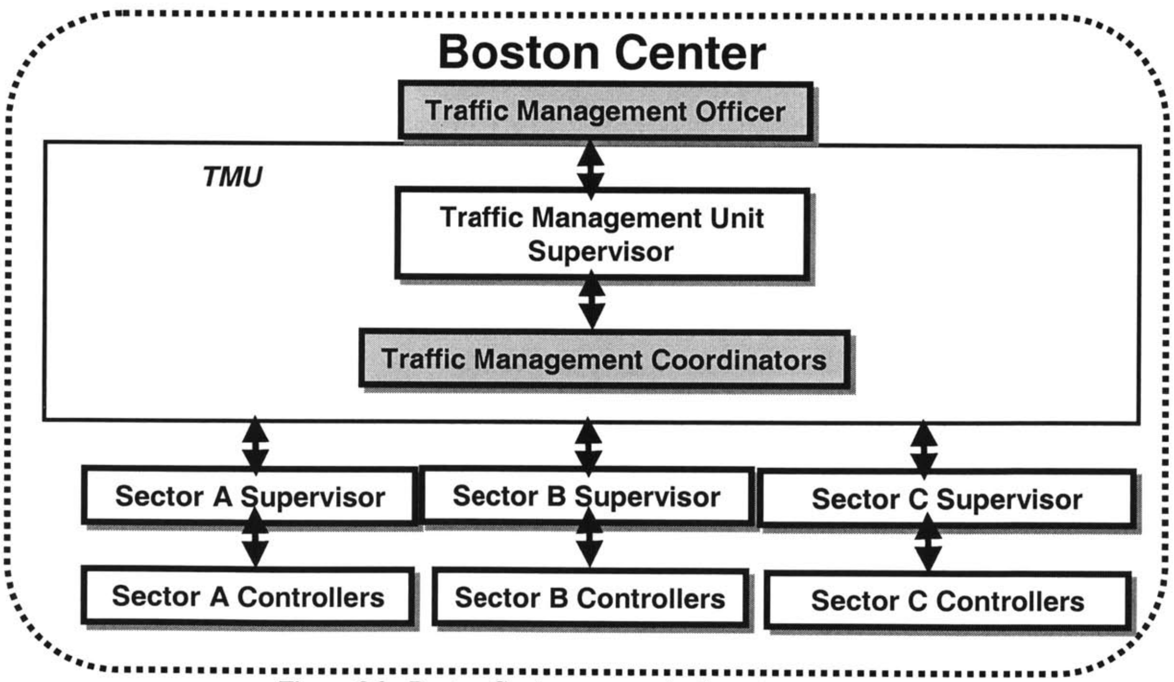

Figure 3.2: Boston Center communication structure.

3.1.1 Boston Center Traffic Management Officer

The Traffic Management Officer (TMO) position at Boston Center (ZBW) is responsible for maintaining maximum efficiency of the overall facility, but also protecting the sector controllers from overload through ensuring the proper traffic initiatives are in place when the conditions demand them. The TMO communicates directly with the Command Center on behalf of the facility. However, this position is a managerial position in which most of his or her time is spent communicating to other facilities either in teleconferences or individually, rather than initiating traffic management initiatives directly. The responsibilities of the Boston Center TMO are:

- Maintain awareness of the current and future operations at the facility
- Relay the current and future state of the Boston Center to both the Command Center and other TMOs
- Provide the final decision on the working capability of the Boston Center
- Maintain awareness of the current and future operations of the NAS that may affect Boston Center in the future
- Relay the NAS issues that may affect Boston airspace to the Boston Center TMU

3.1.1.1 Coordination and Communication Structure

Based on the results of the interview, the nominal communication structure of the Boston TMO is shown in Figure 3.3. The different individual positions with whom the TMO communicates are then discussed further.

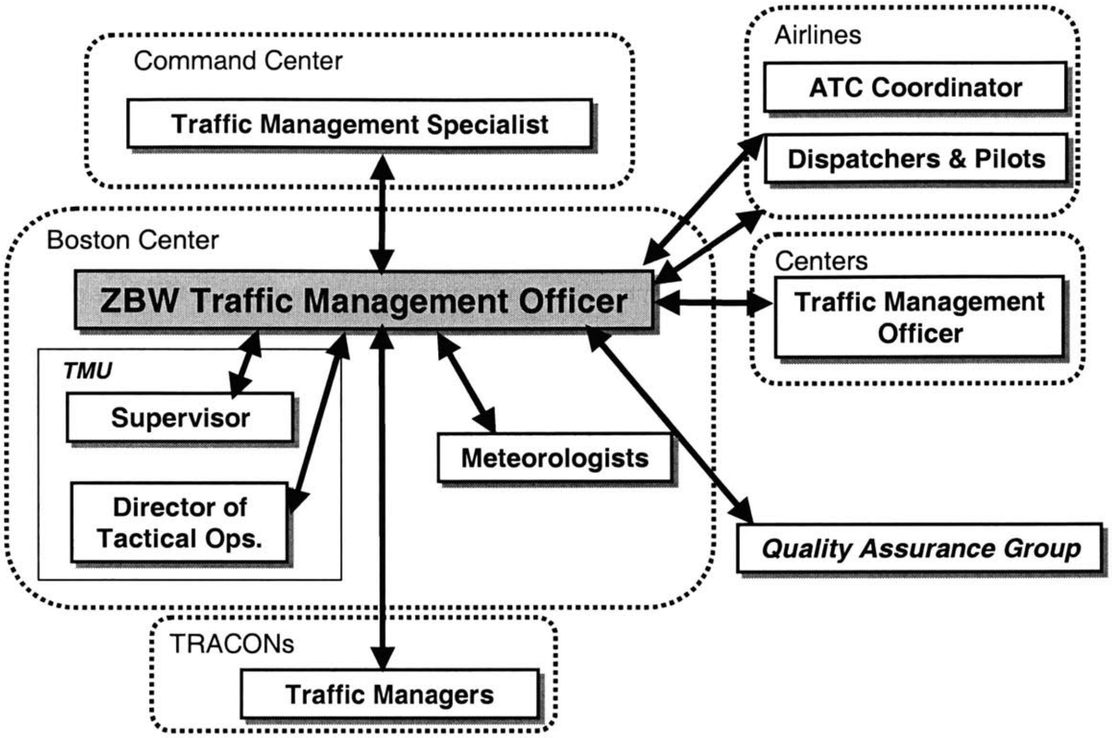

Figure 3.3: Boston Center Traffic Management Officer communication structure.

Director of Tactical Operations

The Director of Tactical Operations in the Center TMU is a liaison to the sector controllers at the Center. The Director of Tactical Operations is included in any teleconference in which the traffic management decision directly affects controller workload or the safety criteria at the facility. The TMO may talk with the Director of Tactical Operations face-to-face or may telephone to ask a question regarding operations.

Boston Center TMU Supervisor

The TMU Supervisor is the head of the Boston Center's TMU. The TMU Supervisor relays the current and future status of the Center to the TMO so that accurate information can be given during the teleconferences. The TMU Supervisor also offers advice to the TMO about the appropriate traffic management initiative to ask for from the Command Center. The TMO may either telephone the TMU Supervisor or talk to him or her face-to-face.

Boston Center Meteorology Unit

The Meteorology Unit is located within the Boston Center and contains qualified meteorologists who offer current and predicted weather information to the Boston Center controllers and TMU. Often the Meteorology unit is consulted before initiating any weather-related traffic management initiatives. These communications may take place either over the telephone or face-to-face. Much of the information on the current weather is communicated through the Doppler weather radar displays located in the TMO office, the TMU area, and near each Sector Supervisor (see Appendix A for more information).

Airline ATC Coordinators

Airline ATC Coordinators are employees of the airlines that are often retired controllers who aid the airlines in communicating with ATC about traffic management issues. TMOs often communicate with airline ATC coordinators to give the airlines the most updated information about status of airspace in the facility. ATC coordinators may also make suggestions to the TMOs to aid the traffic management strategies. Often, this communication is initiated by the ATC Coordinator and is a way of maintaining information flow from ATC to the airlines. The ATC coordinator may contact the TMO through the telephone for a time-sensitive situation, or through e-mail for more general questions.

Airline Dispatchers & Pilots

Airline Dispatchers are airline employees that are responsible for the pre-flight planning, delay and dispatch release of a group of flights for a particular airline. The TMO may field questions through e-mail or telephone from an airline dispatcher or a pilot. These communications may involve questions about certain procedures or the status of certain aircraft. The TMO uses the Traffic Situation Display and the Flight Schedule Monitor to determine current and predicted traffic demand from the airlines (see Appendix A for more information)

Other Center TMOs

The TMOs from adjacent Centers such as New York Center, Cleveland Center, Toronto Center, and Montreal Center are critical to the traffic negotiations process of the Boston Center TMO. The TMO is often negotiating with other TMOs about how to reduce restrictions, how to deal with overflow in traffic by re-routing entire flows, or planning temporary reroutes for future traffic impediments. Most of these communications are carried out through the telephone, but on occasion the TMOs may communicate through e-mail.

Boston area TRACON TMOs

The Boston area TRACON TMOs hold the head managerial position at the TRACON facilities within the Boston Center airspace. Often the communication between the Center TMO and the TRACON TMOs involves relaying the most up to date information about the status of the TRACONs to include in teleconferences, held 6-8 times per day. Any emergencies or problems at the TRACONs are communicated immediately to the Center TMO to prevent traffic overflow into the TRACON. The TMO will talk on the telephone to the TRACON, but if arrival rates or departure rates are readily available on the Command Center website, the TMO may check the Internet for TRACON information instead.

Command Center Traffic Management Specialist

The Command Center TMS is the Command Center representative assigned specifically to the Boston Center area to aid the Center in maintaining maximum efficiency, reducing any negative impact that Boston Center might have on the national flow. The TMO speaks mostly to the TMS through teleconferences that occur every two hours. Strategic traffic management plans are made during this time that may last the entire day, if no problems occur. If problems occur within Boston airspace, the TMO immediately notifies the TMS. Communicating information from the TMS to the TMO may also occur when the TMO checks the Command Center website for updated traffic initiatives (see Appendix A for more information).

Quality Assurance Group

The equipment at the Center is maintained by a group called Quality Assurance. On occasion, the TMO may need to make staffing alterations based on the estimates of repair made by the Quality Assurance group. Information from the Quality Assurance Group is passed to the TMO either through telephone conversations or through e-mail.

3.1.1.2 Communication and coordination problems

In the interview, the Boston TMO described the communication problems and coordination issues below:

Information quality can be poor: Since many of the decisions made by the TMO are based on the most recently updated demand estimates and the latest weather forecasts, the decisions will be poor if the information that they are based on is poor. The nature of the TMO position demands the latest information available about the airspace in question.

Information availability: Many of the decisions made in teleconferences are based on shared information, therefore if one party is without a set of information, decisions cannot be made efficiently.

3.1.1.3 Suggestions for improved communications/coordination

The Boston TMO suggested that more frequently updated and more accurate information would benefit the decisions made, including information about:

- Demand estimates
- Weather forecasts
- Tactical controller workload limitations
- Controller staffing information

3.1.2 Boston Center Traffic Management Coordinator

There are approximately 5-7 Traffic Management Coordinators (TMCs) in the Traffic Management Unit in the Boston Center during the day. The functions of the Boston TMCs are as follows:

- Monitor the state of tactical controllers through the sector supervisor to ensure that no sector is overloaded with aircraft
- Determine when a traffic initiative is required to control the flow of traffic into or out of Boston Center

- Communicate restrictions from other facilities that affect traffic into or out of Boston Center to the sector supervisors to be implemented by the tactical controllers
- Advise the TMO on what strategic traffic measures should be taken and why

In addition to the regular duties listed above, each TMC also has a specialized duty to perform. The TMC may keep this duty throughout the whole shift if he or she is performing extraordinarily well, but often the TMCs rotate duties throughout the day. These duties are listed below:

- Desk Controller: answers telephone calls from other facilities, phones other facilities to find information for another TMC
- Military Coordinator: coordinates paperwork and flight data for all military exercises within Boston Center airspace
- Oceanic Planner: arranges the morning and evening trans-Atlantic routes from New York Center to Gander Oceanic Area Control Center and from Gander Oceanic Area Control Center to New York Center
- Re-route Coordinator: responsible for re-routes of individual aircraft within Boston Center
- Departure Spacing Planner: active only during departure spacing program restrictions on the Boston airports; arranges the departure releases of Logan Airport and other regional airports to maintain a steady, but controlled flow into Boston Center airspace
- Metering Controller: active during metering restrictions; monitors flow of aircraft from Boston Center into Boston TRACON and determines what miles-in-trail aircraft restriction is required to maintain a reasonable flow from the Center
- Weather Coordinator: responsible for re-routes of entire traffic flows through Boston Center due to severe weather in Boston Center airspace

3.1.2.1 Communication and Coordination Structure

As elicited from the interview, the nominal communication structure of the Boston TMC is depicted below in Figure 3.4.

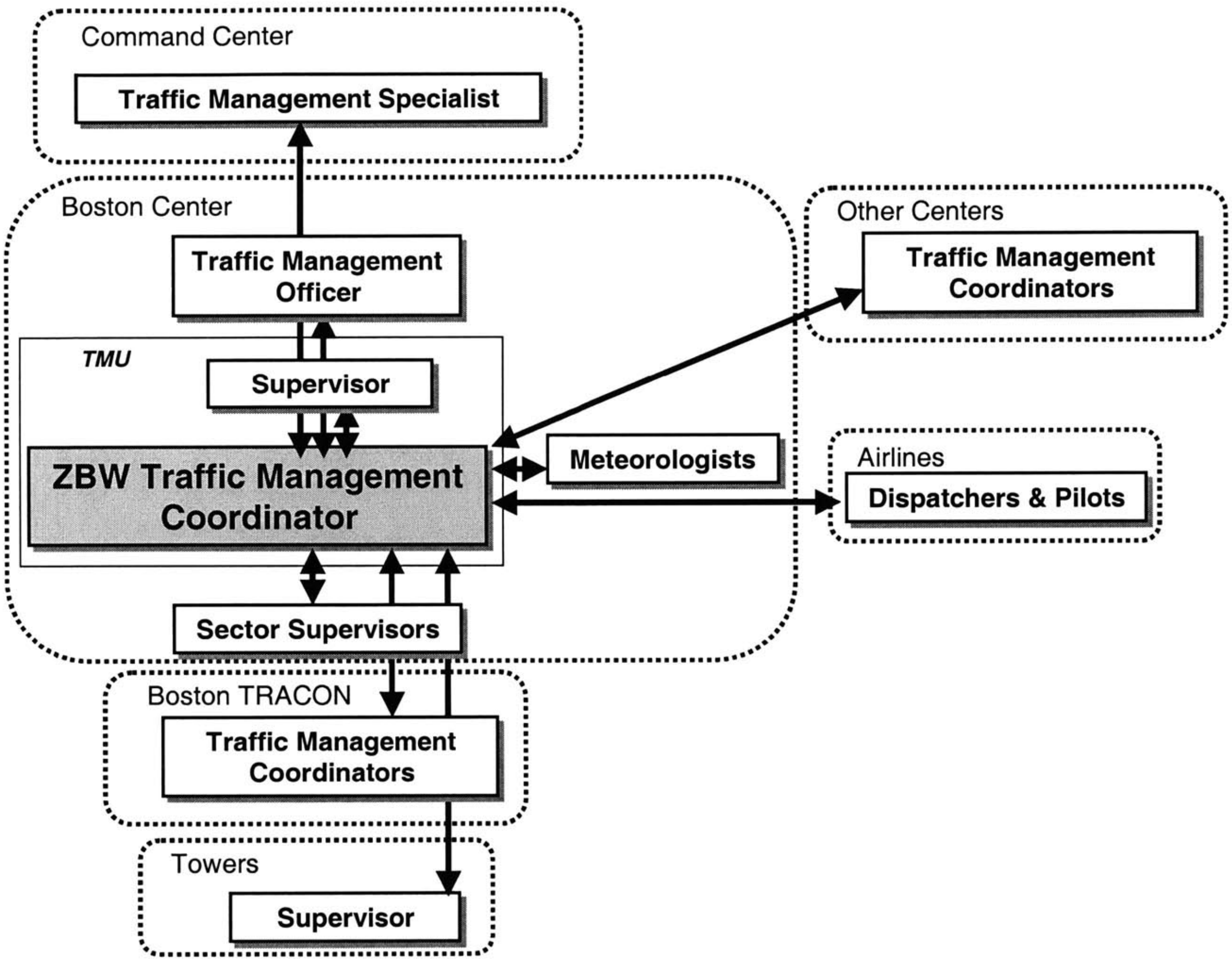

Figure 3.4: Boston Center TMC communication structure.

Command Center Traffic Management Specialist

The Command Center TMS is responsible for ensuring that Boston facilities are functioning at maximum efficiency. Strategic traffic management plans are made during the teleconferences that may last the entire day, if no problems occur. If problems occur within Boston airspace, the Boston Center TMC immediately notifies the TMS. Communicating information from the TMS to the Boston Center TMC may also occur when the Boston

Center TMC consults the Command Center website for updated traffic initiatives (see Appendix A for more information).

Boston Center TMU Supervisor

The Boston Center TMU Supervisor is responsible for the operations occurring within the TMU. The Supervisor is consulted before any traffic management program is initiated, and the Supervisor is kept updated on the status of the facility. There is constant face-to-face communication between the Center TMC and the TMU Supervisor.

Other Boston Center TMCs

The Boston Center TMC consults with other TMCs within the TMU throughout his or her duties. The TMC will retrieve information from other TMCs or ask their advice face-to-face constantly throughout the day.

Boston Center Meteorology Unit

The Meteorology Unit is located within the Boston Center and contains qualified meteorologists who offer current and predicted weather information to the Boston Center controllers and TMU. Often the Meteorology unit is consulted before initiating any weather-related traffic management initiatives. These communications may take place either over the telephone or face-to-face. Much of the information on the current weather is communicated through the Doppler weather radar displays located in the TMO office, the TMU area, and near each Sector Supervisor (see Appendix A for more information).

Boston Center Sector Supervisors

The Sector Supervisors are responsible for monitoring the workload of the tactical controllers within their assigned area. The Center TMC communicates with the Sector Supervisors to both provide information about the newly implemented traffic management programs or to gather information on the current load of the tactical controllers.

Other Center TMCs

TMCs from adjacent Centers have the ability to provide important demand information and controller workload information to the Boston Center. The communication with TMCs from other Centers occurs through telephone or e-mail.

Airline Dispatchers & Pilots

Airline Dispatchers are airline employees that are responsible for the pre-flight planning, delay and dispatch release of a group of flights for a particular airline. The Boston Center TMC may field questions through e-mail or telephone from an airline dispatcher or a pilot. These communications may involve questions about certain procedures or the status of certain aircraft. The TMC uses the Traffic Situation Display and the Flight Schedule Monitor to determine current and predicted traffic demand from the airlines (see Appendix A for more information).

Boston area TRACON TMCs

The TRACON TMCs from the Boston area are responsible for the efficiency of the TRACONs while preventing TRACON controllers from becoming overloaded with traffic. Communication occurs constantly with the TRACONs to ensure that proper restrictions are being met by the TRACONs.

Boston area Tower TMCs

The Tower TMCs within the Boston Center airspace are responsible for the efficiency of the Tower operations while preventing the Tower controllers from becoming overloaded with arrivals. Communication occurs when runway configurations or arrival/departure rates have changed at the Towers and during emergencies.

3.1.2.2 Communications and coordination problems

The Boston Center TMC mentioned several problems with communication and coordination in Boston Center TMU:

Difficulty in understanding when Boston TRACON controllers get overloaded: During metering restrictions, it is important to be able to predict when controllers at the adjacent facility will become overloaded so that the miles-in-trail can be increased in time to have an effect. By the time the TRACON TMC telephones to tell the Metering position that the controllers are getting overloaded, it is often too late to put more miles-in-trail, so holding patterns begin at the handoff point. According to the TMCs, the most effective TMC performing metering duties is the person that has worked at Boston TRACON and knows that the controllers are getting overloaded when they begin taking handoffs late, they are turning aircraft on a 30 mile final approach, and the voice of the TRACON TMC becomes strained due to stress of high traffic.

Re-routing process is not dynamic enough for many situations: Re-routing flows of aircraft requires a great deal of coordination not only within Boston Center, but between Boston and other Centers. Because of this coordination effort, the re-route process is slowed down. The most difficult re-routes are those that require diverting into Canadian airspace, which require international approval.

Perceived lack of authority when communicating with Command Center: Many of the Command Center's efforts in the northeast require that traffic initiatives favor New York, due to the complexity of the airspace and New York's effect on the national flow. Boston Center TMCs feel that they have to over-justify reasons for traffic initiatives on flights into Boston because New York is favored. "New York gets whatever they want," said one Boston Center TMC.

Information sources are too dispersed: The ETMS, Host computer, and Command Center website (OIS) all contain important information that is constantly updated (See Appendix A for more detail). In addition to the multiple tasks required of the Boston Center TMCs, they must remain aware of each of these systems to form a complete picture of the air traffic situation. However, it is difficult to remain current on all information due to the lack of integration of the information sources.

3.1.2.3 Suggestions for communication/coordination improvement

The Center TMC provided several suggestions for improving inter-facility communication and coordination at the Boston Center:

Increase familiarization visits: By understanding the operations at the complementary facility, the TMCs from the TRACON and Center can better suggest traffic options that the other TMC would accept as a solution. By developing acquaintances at the other facility, the TMCs might be more flexible in traffic management issues when communicating with a friend. Just the effort of trying to understand the other TMCs' issues makes the communication proceed more smoothly.

Automate the re-routes used: When re-routes of aircraft are required due to weather or traffic demand, many of the chosen re-routes are used routinely in the TMU. By standardizing and automating these re-routes, the communication and coordination is minimized, which makes the re-route process more efficient.

Integrate information sources into one secure Internet source: The ETMS, OIS website, and Host computer should be integrated to reduce the time required to update and be receive updates on the air traffic situation relative to each source individually.

3.2 Boston TRACON (A90)

The Boston TRACON is located at Logan International Airport. The Tower facility is located a few floors up from the TRACON, making the terminal facility an "up-down" facility with both the Tower and TRACON in the same building. The Boston TRACON handles arrivals and departures out of Logan Airport, Hanscom Airport and several other regional airports. The Boston TRACON airspace is depicted in Figure 3.5 below.

The communication structure of the Boston TRACON is pictured below in Figure 3.6. As can be seen from the figure, there is only one TMC who is in direct communication with the TRACON supervisor and each of the tactical controllers.

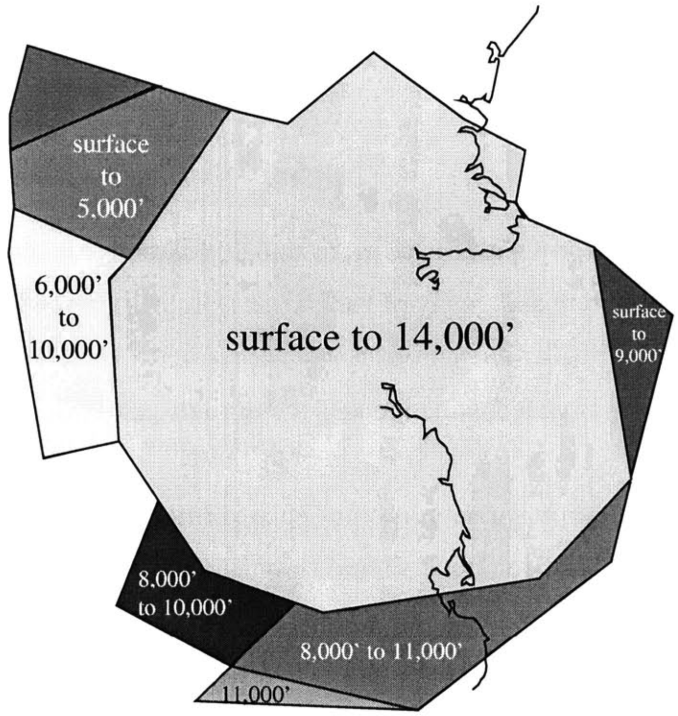

Figure 3.5: Boston TRACON airspace.

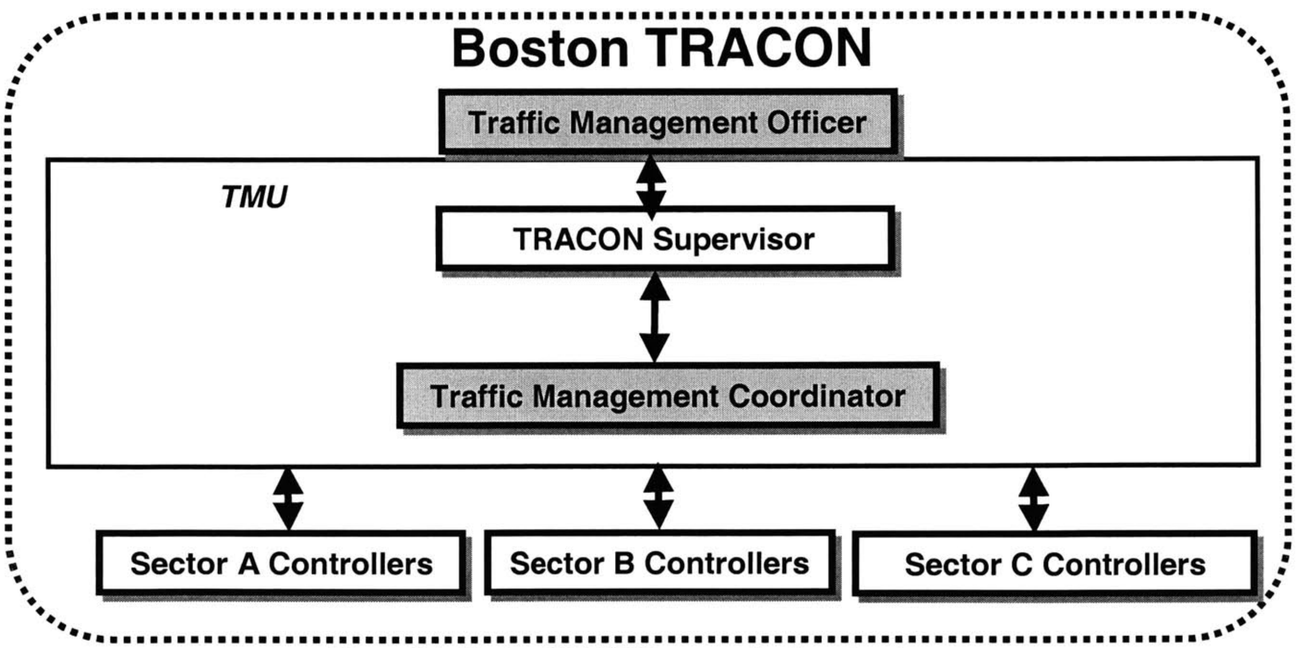

Figure 3.6: Boston TRACON communication structure.

3.2.1 Boston TRACON Traffic Management Officer

The TRACON TMO is the spokesperson for the Boston TRACON. He or she is not directly involved in the moment-to-moment operations of the TRACON, but rather in the more strategic effect of the facility on the entire NAS. The functions of the TRACON TMO are listed below:

- Maintain awareness of the current and future operations at the facility
- Relay the current and future state of the Boston TRACON to both the Command Center and Boston Center
- Provide the final decision on the working capability of the Boston TRACON (namely in the form of Arrival Rates and Departure Rates for each runway configuration)
- Maintain awareness of the current and future operations of the NAS that may affect Boston TRACON in the future
- Relay the NAS issues that may affect Boston airspace to the Boston TRACON TMU

3.2.1.1 Communication and coordination structure

As elicited from the interview, the communication structure of the TRACON TMO is depicted below in Figure 3.7. Communications of the TRACON TMO with the individual positions are then discussed further.

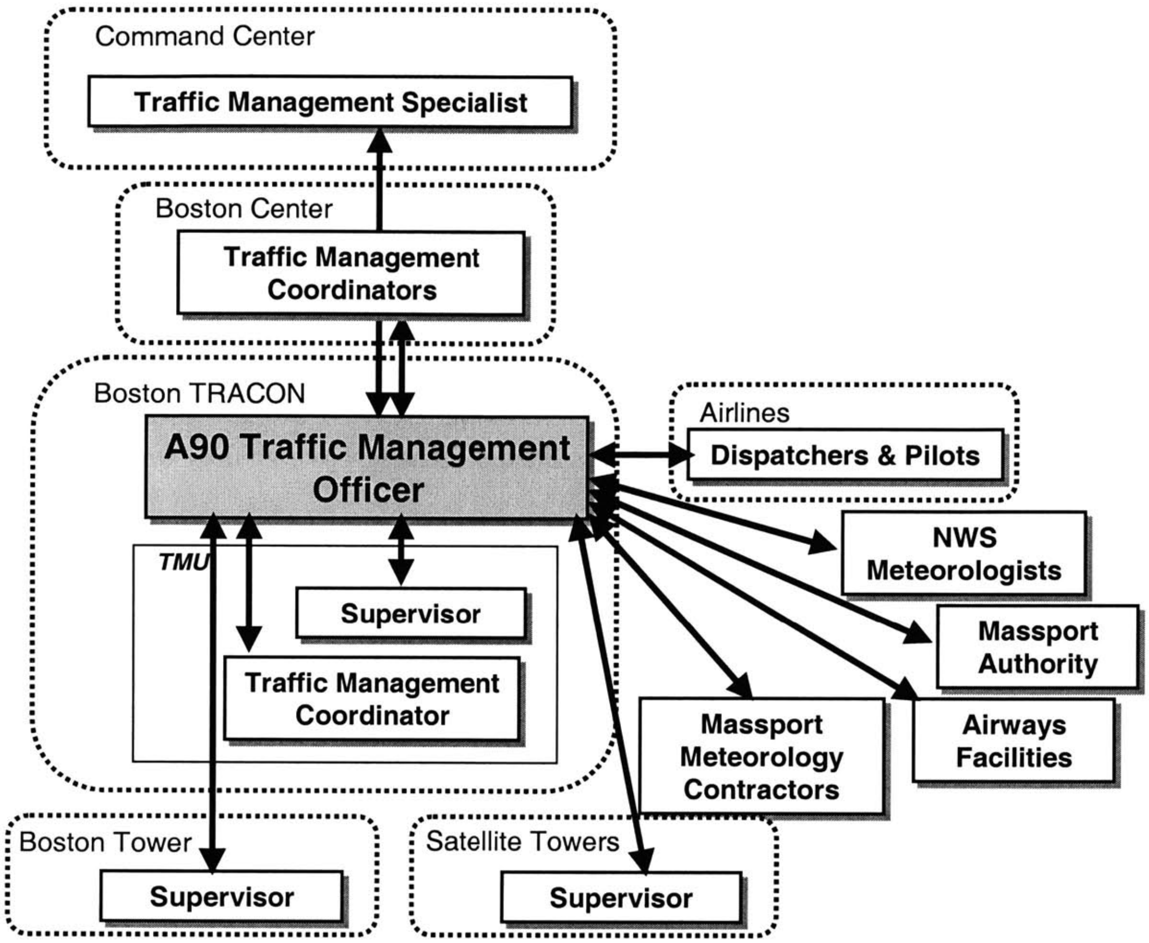

Figure 3.7: Boston TRACON TMO communication structure.

Boston TRACON Supervisor and Boston TRACON TMC

The TRACON Supervisor is responsible for overseeing the operations within the TRACON. The TRACON TMC is responsible for the inter-facility communications between the TRACON and other facilities. Since the TRACON TMO is responsible for maintaining an updated understanding of the situation at the TRACON, much of this information is retrieved from the TRACON Supervisor and the TRACON TMC. One or two face-to-face conversations about the plan of the day will suffice to convey an adequate amount of information on a day with no interrupted operations. When something unexpected happens in the TRACON (e.g., weather developments), the Supervisor or TMC telephones the TMO to ensure immediate acknowledgement of the situation in case the TMO is telephoned about the situation from another facility. The TMO also communicates any significant decisions made in the daily teleconferences to the Supervisor and TMC.

Boston Tower Supervisor

The Tower Supervisor is responsible for overseeing operations in the Tower facility. To determine the arrival rate and departure rate, the TMO must communicate frequently with the Tower Supervisor to determine the runway configuration that is being used. Anytime the winds change, the Tower Supervisor will correspond with the TMO to inform the TMO regarding which runway configuration will be used. The configuration used may require a change in the arrival or departure rate. The Tower may also be telephoned if the TMO requires other airport information to make a decision, such as visibility at the airport.

Massport Meteorology Contractors

A portion of the weather information that the TMO uses is determined from a daily weather report provided by the Massport Meteorology Contractors. This will help determine whether the winds will change during the day, affecting the runway configuration and the arrival/departure rates. The TMO will telephone the meteorologists for a report if needed. Much of the information on the current weather is communicated through the Doppler weather radar displays located in the TMO office and in the TMC's area (see Appendix A for more information).

Massachusetts Port (Massport) Authority

The Massport Authority is responsible for maintaining the runways and ensuring the airport is operational so as not to inhibit air traffic operations. If interrupted operations are caused by runway or gate issues, the TMO may telephone the Massport Authority to gain an estimate of when the issue will be fixed to aid in planning traffic initiatives.

Boston Center TMU

The Boston Center TMU is responsible for maintaining safe and efficient operations throughout the Boston Center airspace. The Boston TRACON TMO will often telephone the Boston Center TMU to arrange strategic traffic management initiatives. He or she may also call the Boston Center TMU to inquire about some information that was not made clear on the computer. The GI Message System/FDIO is used by the TRACON TMO to maintain updates on new or revised restrictions passed from the Boston Center to the TRACON (see Appendix A for more information).

Boston Center Meteorologists

The Center Meteorologists provide a daily forecast by fax to all Boston facilities. The TMO uses this forecast as a main source of weather information from which to base the arrival and departure rates for the day and to provide estimates on the teleconferences of what kind of performance to expect from the Boston TRACON for the day.

Command Center Traffic Management Specialist

The Command Center TMS is responsible for ensuring that the Boston facilities maintain efficient operations and have little negative impact on the national flow. The Command Center TMS is briefed on teleconferences at least once per day about the past and future performance of the Boston TRACON. The TMO also uses these teleconferences as a forum in which to inform the Command Center of any expected operational issues that the TRACON may be facing in the future such as weather. In addition, any time the TRACON faces interrupted operations, the TMO must immediately inform the Command Center of the situation to prepare them for traffic initiatives to prevent overload on arrivals to Logan Airport.

National Weather Service Meteorologists (Taunton, NH)

The NWS provides the TRACON with a daily fax of weather forecasts for that day. The Boston TRACON TMO compares this forecast with the forecast from the Center, and if they disagree, the Massport meteorologist contractors are consulted.

Satellite Airport Tower TMOs

The satellite airport Tower TMO's, such as those from Hanscom Airport, are those positions that are responsible for operations at the Tower facilities. The Boston TRACON TMO rarely communicates with the satellite airport Tower TMOs, and only when the satellite airports are having problems accepting the TRACON traffic or if they are competing with Logan on certain departure routes. As Manchester airport increases in demand, the TMO must resolve the issue of interweaving traffic from both Logan and Manchester into the departure flow. These communications will take place through the telephone.

Airways Facilities

The Airways Facilities may also be contacted to determine estimates on airport maintenance tasks that affect operations. These communications are rare (only during airport maintenance) and occur over the telephone.

Airline Dispatchers, Airline ATC Coordinators and Pilots

The Airline Dispatchers, ATC Coordinators or Pilots may contact the TRACON TMO to ask a specific question about the operations at the facility if the airline's pilots are unclear about something. This will generally arrive by e-mail, or possibly by telephone. The TRACON TMO will then answer the question through e-mail. Questions from airlines are a rare occurrence. Sometimes questions or comments to the TRACON will be included on the quarterly user forms that are completed by the airport tenants and chief pilots. The TRACON TMO will often be asked to explain why certain procedures are used or not used or why there were delays on a particular day. The TMO uses the Traffic Situation Display and the Flight Schedule Monitor to determine current and predicted traffic demand from the airlines (see Appendix A for more information).

3.2.1.2 Communication and coordination problems

Communication problems listed by the TRACON TMO during the interview are provided below:

Too much time is spent by TMO and TMC entering restrictions and information into the separate data systems: The TMO responded in the interview that the TMCs spent too much time transferring information into multiple information systems. This reduces the TMC's time for their major task, which is monitoring the tactical controllers and managing flows.

Command Center TMSs are often unfamiliar with the sector over which they are responsible: The Command Center requires "familiarization visits" to the facilities with which the TMS has had no experience, but the visits do not thoroughly cover the day-to-day operational experience that is necessary to adequately aid the facility at the national level. According to the TRACON TMO, the lack of knowledge of airspace affects whether the TMS knows the impact of a traffic initiative on a specific airport.

The terminal facilities have lost the ability to negotiate flow situations with the Center: The Center used to place departure miles-in-trail restrictions on the airports within Boston Center airspace, and they would allocate more departure slots for Logan Airport due to the large demand of this airport. The Center has abandoned this strategy and favors all airports equally, so there are no delays at the smaller airports and 4-6 hour delays at Logan Airport.

3.2.1.3 Suggestions for improving communication and coordination

Suggestions for improving communication were also provided by the TRACON TMO and are listed below:

Increase the TMC familiarization visits to other facilities: The TMO said that it helps to make negotiations smoother if the TMC knows the person on the other side of the telephone. The visits are not funded by the FAA but supervisors find a way to make them happen. These visits are important because the relationships between TMCs are formed and a better understanding of the operations is valuable to the operations at the TRACON.

Integrate the information systems into one comprehensive system: Too much time is spent entering data into three different systems, so having one system to update and check for new information would be valuable. The TMCs would then spend more time monitoring the tactical controllers and the controllers would receive information in a timely manner.

3.2.1.4 Other observations

During the interview with the Boston TRACON TMO, issues surrounding the reasons for ATC system delays and the effect of centralized flow control were discussed. The observations made by the Boston TRACON TMO are presented below.

Bottlenecks in the air traffic control system

The TRACON TMO had two explanations for the current delays in the air traffic system today. "It is difficult to get facilities to take on extra workload for the system good," said the TMO. "Because most smaller airports don't have a TMU, they just see it as taking on extra workload to make it easier for Boston, and think, why should we do that?"

The TMO also said, "Airline scheduling is the major problem. On a good day, Boston can handle a maximum of 68 aircraft an hour. The airlines schedule a peak demand of 58 aircraft an hour. This is fine as long as conditions do not vary from perfect. They [often] do, and we often have to cut operations to half the maximum, or around 30-35. What happens is that the delayed aircraft are propagated to the next hour, and more flights are delayed. The scheduling is the problem. We are subject to environmental circumstances beyond our control."

Command Center and centralized flow control

The TMO said that centralizing flow control was a good idea, because the inefficiency in communication was cut down. However, the TMO stated that it can also be a bad process if the TMS has had no experience controlling in the sector over which he or she represents. It is difficult for the TMS to understand the impact of a Ground Delay Program at a specific airport if he or she has had no experience at that facility. The conference calls can help this situation, because they provide a way to provide an explanation to the Command Center about why certain procedures were used to deal with a specific problem on the day that it was enacted instead of a day or a week later.

3.2.2 Boston TRACON Traffic Management Coordinator

At the Boston TRACON, there is a single Traffic Management Coordinator on duty during the day. The functions of this TMC are to:

- Monitor state of tactical controllers to ensure that no sector is overloaded with aircraft
- Determine when a traffic initiative should be put on traffic into or out of Boston TRACON

- Communicate restrictions from other facilities that affect traffic into or out of Boston TRACON to the TRACON supervisor and the tactical controllers to be implemented
- Advise TMO on what strategic traffic measures should be taken before teleconferences and why and what performance to expect out of the TRACON during a particular day

3.2.2.1 Communication and coordination structure

Pictured in Figure 3.8 below is the communication structure elicited from the TRACON TMC during the interview. Discussion about the individual communications between the TRACON TMC and the other parties follows.

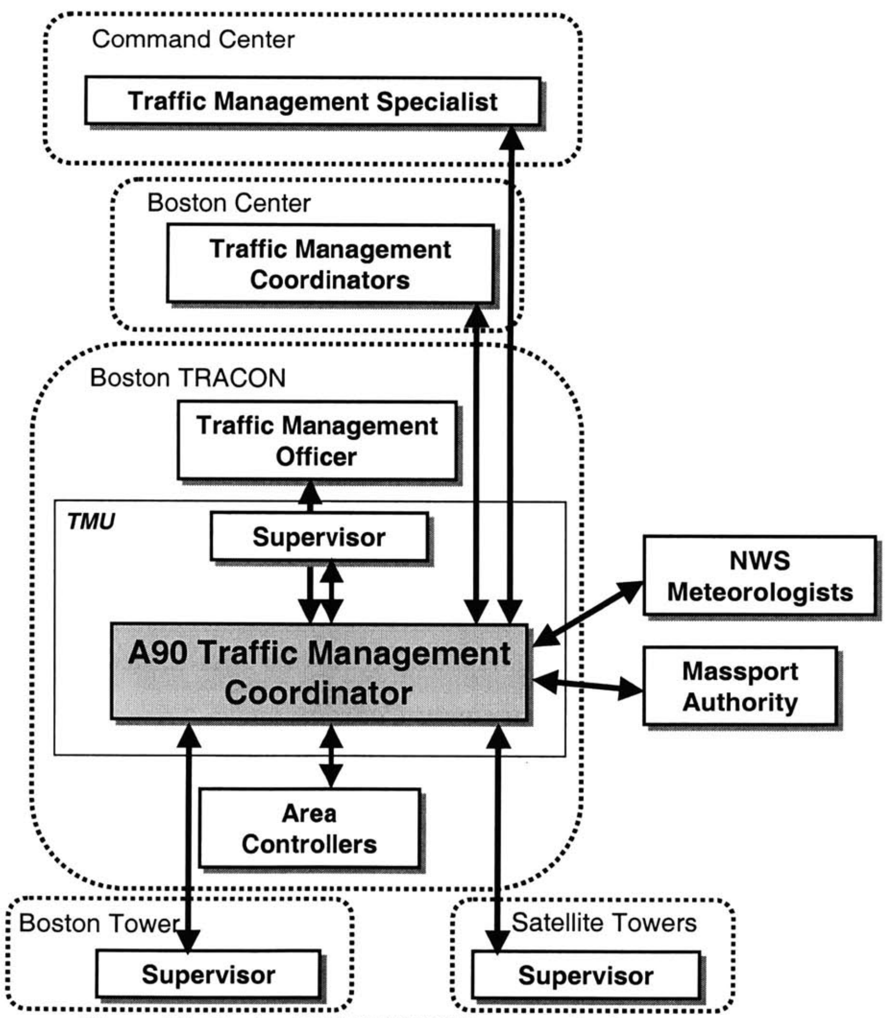

Figure 3.8: Boston TRACON TMC communication structure.

Boston TRACON Traffic Management Officer

The Boston TRACON TMO is the managerial head of the Boston TRACON. The Boston TRACON TMC communicates with the TMO 3-4 times per day in short face-to-face meetings. These meetings consist of advising the TMO on the current performance characteristics of the TRACON based on staffing, weather, and runway configuration. The TMO might also advise the TMC of issues that have arisen in the teleconferences throughout the day that may affect operations in the TRACON.

Boston TRACON Supervisor

The TRACON Supervisor is responsible for operations within the TRACON. The Supervisor is consulted before any traffic initiative is recommended to Boston Center. The TMC may also communicate with the Supervisor to receive a second opinion on the traffic management strategy being considered. The TMC will communicate with the Supervisor 5-10 times per day on average during short face-to-face meetings.

Boston TRACON Sector controllers

Part of the TMC's function is to monitor the controllers in the TRACON for signs of overload, therefore the TMC is in constant communication with these controllers. Often, information is gathered by the TMC about the controllers by watching over the controller's shoulder and listening to the pitch and inflection of their voices. Occasionally, the controller will directly tell the TMC that a traffic initiative will be needed, but more often, this need is anticipated by the TMC.

Boston Center TMCs

The Boston Center TMC is responsible for maintaining efficient flows throughout the Center's airspace without overloading any one sector. Most of the Boston TRACON TMC's communication is with the TMCs at the Boston Center, contacting one another 5-30 times per day depending on the traffic situation. When a restriction for the TRACON is needed, the TMC will telephone the Center to request and often justify the need for a program. The Center often communicates information to the TRACON through the FDIO/GI message system. The FDIO/GI Message System is used by the TRACON TMC to maintain updates on new or revised restrictions passed from the Boston Center to the TRACON.

Command Center Traffic Management Specialist

The Command Center TMS is responsible for maximizing the efficiency of the Boston facilities in relation to the national traffic flow. The Boston TRACON TMC communicates with the Command Center between 5 and 15 times per day. These communications consist of the TMC requesting a traffic program directly from the Command Center, or when a TMS is requesting performance information from the TRACON TMC, namely arrival and departure rates for the future. Arrival and departure rates as well as runway configuration can be retrieved by consulting the Command Center website if they are updated frequently by the TRACON TMC (see Appendix A for more information).

National Weather Service (Taunton, NH)

The NWS provides 2 forecasts per day to the TRACON by fax: one in the early morning, and one in the afternoon. Further weather information can be obtained from Boston Center meteorologists and the Doppler Weather Radar display. Much of the information on the current weather is communicated through the Doppler weather radar displays located in the TMO office and in the TMC's area.

Massachusetts Port Authority (Massport)

The Massport Authority is responsible for maintaining the runways and ensuring the airport is operational so as not to inhibit air traffic operations. Massport may be contacted up to 2-3 times per day by telephone to retrieve estimates on length of construction or maintenance that affects operations in the TRACON.

Boston Tower TMC

The Tower TMC is responsible for inter-facility communications on behalf of the the Boston Tower facility. The TRACON TMC communicates often with the Tower TMC, either to retrieve visual information or information on runway configuration or conditions. These communications occur often by phone, up to 10 times per day.

3.2.2.2 Communications and coordination problems

Several items were listed during the interview by the TRACON TMC as communication problems and coordination issues:

Telephones not answered in a timely fashion at the Boston Center TMU: Often during busy periods, the telephones at the Boston Center TMU are not answered, and delays for some aircraft can climb to 40 extra minutes.

Metering program used by Boston Center is unpredictable and illogical: The metering program used by Boston Center to aid the placement of miles-in-trail between aircraft entering the TRACON airspace is an aging program used only by two Centers in the NAS. The times assigned by the program are often incorrect due to outdated information in the database about the aircraft. This, in turn, makes the miles-in-trail incorrect and either overloads TRACON controllers or provides too few aircraft to them. Even if the metering times are correct, it is the responsibility of the Center tactical controllers to meet those times, which often does not happen making the metering less reliable than the miles-in-trail restriction.

Communications between TRACON and Center TMU are inefficient: Communications involving the location of aircraft expected to enter TRACON airspace and often used re-routes of aircraft could be solved relatively easily through updated procedures and information sharing.

3.2.2.3 Suggestions for improving communications and coordination

The TRACON TMC also provided possible enhancements to communication and coordination during the interview, which are listed below.

Automate specific re-routes: Many of the telephone calls made to the Center are to confirm re-routes. Often, the re-routes that are used are used weekly, and the communication would become more efficient if these re-routes were simply automated and standardized.

Cease using the metering program, or at least provide the TRACON TMC with the metering list used by the Center TMC: Other communications between the TRACON TMC and the Center TMU involve determining the location of a specific aircraft expected to enter TRACON airspace. If a metering list could be provided to the TRACON, the communications about expected handoffs would be streamlined.

TRACON should control the low-altitude holding patterns of aircraft on arrival into Logan airport: By passing responsibility of these holding patterns to the TRACON, inter-facility communication could be reduced and the traffic flow into Logan could be better controlled.

3.2.2.4 Other observations

During the interview with the Boston TRACON TMC, issues concerning re-routing constraints and procedures relating to the Boston TRACON were discussed. The results of these discussions are provided below.

Re-routing constraints

To avoid "snowballing" problems by initiating a new, unfamiliar route for traffic, traffic flows are either re-routed along standardized routes or put into holding patterns. The standardized routes are included in either the Standard Operating Procedures of a facility or in the Letters of Agreement with another facility. If a new route were to be suggested, approval would have to be found in every facility affected and other traffic flows would likely be changed as well. Since re-routing on standardized paths is difficult and time-consuming on its own, TMCs are reluctant to deviate from this standardization even if it sacrifices efficiency.

Flow re-route procedure at the Boston TRACON

Once a need for flow re-route is determined, the TMC consults the TSD and weather radar for information. The TRACON Supervisor is consulted about alternate routings. An alternative list is conceived, and the TMC telephones the Center TMU with selected alternatives. The TMCs from both facilities discuss the alternatives and find an alternative suitable to both facilities' operations. The aircraft are either put into holding patterns or a Ground Departure Program is used until the volume is considered reasonable by the TMC at the TRACON.

3.3 Boston Tower (BOS)

The Boston Tower is located above the Boston TRACON on site at Logan International Airport. The Tower is responsible for releasing departures out of Logan Airport and arrivals into the airport as well as organizing taxiing operations at the airport.

3.3.1 Boston Tower Traffic Management Coordinator

There are 1-2 Traffic Management Coordinators on duty at Boston Tower during the day. The tasks of the Boston Tower TMCs include:

- Monitoring the state of tactical controllers to ensure that the Tower is not overloaded with arriving aircraft
- Determining when a traffic initiative should be put on traffic into Boston Tower
- Communicate restrictions from other facilities that affect traffic into or out of Boston to the Tower controllers to be implemented
- Advise other ATC facilities on what performance to expect out of the Tower during a particular day
- Organize the release of individual aircraft or flows of aircraft

3.3.1.1 Coordination and Communication Structure

Figure 3.9 displays the current communication structure of the Boston Tower TMC, as elicited from the interview. Below the figure are descriptions of the individual communications that occur between the TMC and other parties.

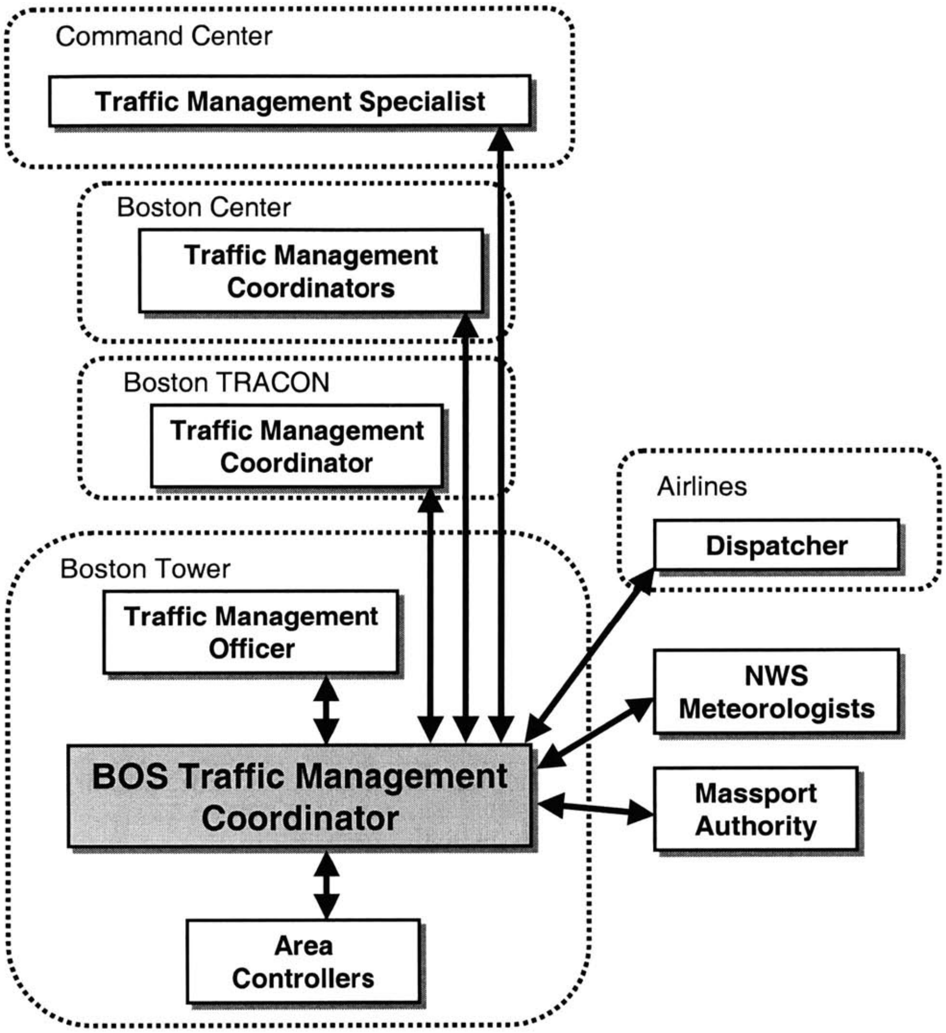

Figure 3.9: Boston Tower TMC communication structure.

Command Center Traffic Management Specialist

The Command Center TMS is responsible for ensuring that the Boston facilities are performing at their maximum capacity to minimize negative effect on national air traffic. The Boston Tower TMC communicates with the TMS during extended delays (in excess of 90 minutes) to coordinate the departure releases of individual aircraft to minimize the ground congestion at the airport. These communications transpire through the telephone approximately 1-5 times per day.

Boston Center Traffic Management Coordinators

The Boston Center TMCs are responsible for maintaining efficiency of the flows into and out of the Boston Center without overloading the tactical controllers. The Tower TMC communicates with the Center TMCs to arrange departure release times during the periods in which the Departure Spacing Planner (DSP) and Estimated Departure Clearance Times (EDCTs) are in effect. Communication also occurs when runways must be closed. The Tower TMC must also report delays for individual or flows of aircraft with the same destination at 15-minute intervals to the Center. On occasion, the Center may contact the Tower to request information on fog or other weather situations visible from the Tower. Communications with the Center TMC transpire by telephone or through the FDIO/GI Message System (see Appendix A) approximately 15 times per hour.

Boston TRACON Traffic Management Coordinator

The Boston TRACON TMC is responsible for maintaining efficient operations through the Boston TRACON while preventing the TRACON controllers from traffic overload. The Tower TMC communicates with the TRACON TMC to organize the plan of operations once per shift. Other discussions include the estimated interval to be expected on arrival into the Tower airspace, runway configuration changes that may occur, runways that must be closed, weather issues, emergencies, and coordinating the release of individual aircraft. Communications with the TRACON TMC may occur 0-10 times per hour depending on the number of restrictions placed on the Boston facilities. These communications occur using the telephone, or, on occasion, face-to-face conversations.

Boston Tower Controllers

The Tower Controllers are responsible for directly communicating with the aircraft arriving and departing from Logan Airport. The Tower TMC is in constant communication with the Tower controllers to ensure that controllers are aware of the current departure restrictions and to monitor the traffic load experienced by the controllers.

Airline Dispatchers

Airline Dispatchers are airline employees that are responsible for the pre-flight planning, delay and dispatch release of a group of flights for a particular airline. The Tower TMC may telephone an airline dispatcher to provide information to the airline about gate availability at the airport, an estimated wait for gate availability, or a revised EDCT time. These communications are not required of the TMC, but provided as a complimentary service to the airlines, which may make the ground operations more expeditious. These communications occur through telephone between 0-3 times per shift.

National Weather Service Meteorologists

The NWS Meteorologists provide weather forecasts to the ATC facilities upon request. The Tower TMC will telephone the NWS at the beginning of a shift to gain information on the type of weather to expect during the shift. Much of the current weather information is retrieved from the Doppler weather radar located in the Tower (see Appendix A for more information). The TMC may also consult the Intellicast Internet website or cable television's "The Weather Channel" to compile a set of weather forecast information.

Massachusetts Port Authority

The Massport Authority is responsible for maintaining the runways and ensuring the airport is operational so as not to inhibit air traffic operations. The Tower TMC may telephone Massport to determine aircraft parking availability, especially for international flights. Massport is also contacted during a runway emergency so that bio-rescue may be dispatched and when debris is present on a runway. The TMC may contact Massport to inform the group about current inbound delays and reasons behind delays, because Massport is the media contact for ATC information. Total communication with Massport amounts to 0-4 times per day by telephone.

3.3.1.2 Communications and coordination problems

During the interview, the Tower TMC related two communications problems that are experienced as a Tower TMC, which are described below.

Restriction information is lost enroute to the Tower: To minimize the amount of communications by the Command Center, the Command Center TMS telephones the Center TMU to inform on revised status to restrictions. The Center then distributes this information to the TRACON and Tower facilities through the FDIO/GI Message System and the Center website. Often, the current status of the restriction fails to arrive at the Towers for an unknown reason. Because of the effort in reducing the number of communications, information is lost on the winding path to the Tower facilities.

Re-routes are not dynamic enough: Because there is so much inter-facility coordination required to re-route traffic flows or aircraft around a weather cell, by the time the re-route is approved, the weather has moved and the re-route is obsolete.

3.3.1.3 Suggestions for improved communication and coordination

The Tower TMC also provided a possible solution to the communication problem in the position of Tower TMC.

Towers should have more direct access to the Command Center: To prevent the information loss on the communication path to the Towers, the Command Center could contact the Towers directly. Another solution might be to send status changes to the facilities electronically so that every facility receives the same restriction at the same time.

3.4 Manchester Facility (MHT)

Manchester facility is located approximately 50 miles northwest of Boston in Manchester, New Hampshire and is Boston's Logan International Airport's main "reliever" airport (Massport website). It is a small facility, serving 6 airlines and composed of both a TRACON and a Tower in the same building. Controllers employed at Manchester work both TRACON and Tower duties, unlike many facilities. Though Manchester is a small satellite airport, it is an up and coming facility that is growing due to the expanding needs of customers who desire low-cost and nearby access to the Boston area. Manchester Airport currently serves over 1.3 million passengers per year (Massachusetts Port Authority, 2001).

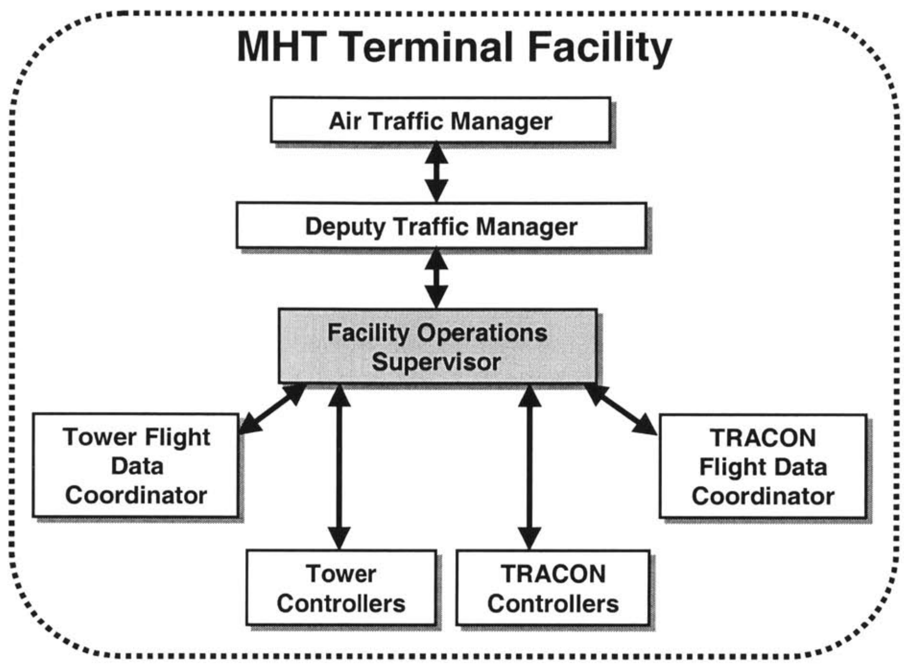

Figure 3.10: Manchester (MHT) facility communication structure.

Due to the low amount of traffic into and out of the airport, many of Manchester's traffic management issues stem from Ground Delay Programs (GDPs) imposed on them by the Boston Center. Overflight traffic into Boston TRACON is also a major source of traffic for the Manchester facility.

The communication structure of the Manchester facility is depicted in Figure 3.10. The person interviewed from the facility held the position of Operations Supervisor, which is highlighted in the figure.

3.4.1 Manchester Operations Supervisor

The Operations Supervisor at Manchester facility is a strategic traffic manager for both the TRACON and the Tower. The Operations Supervisor position at Manchester is similar to that of the TMC at the Boston facilities, in that the Operations Supervisor is the primary inter-facility communications link between Manchester and other facilities. The Operations Supervisor's tasks are:

- Monitoring the tactical controllers to ensure that they are working at capacity and not getting overloaded with aircraft
- Determining what traffic initiative should be put in place when it is warranted
- Maintain awareness of any restrictions on flights departing
- Ensure that the restrictions on departures are met by the Manchester Tower and Manchester TRACON controllers
- Communicate the current state of the facility to Boston Center

3.4.1.1 Coordination and Communication Structure

Figure 3.11 displays the current communication structure of the Operations Supervisor, as elicited from the interview. Further discussion on individual communications of the Operations Supervisor is included below.

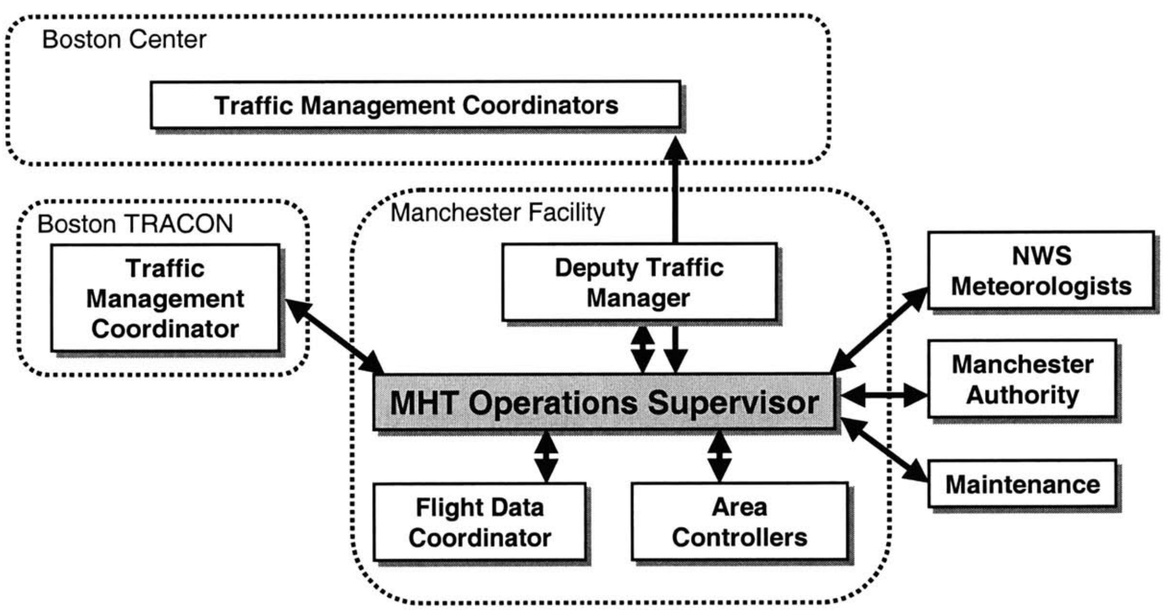

Figure 3.11: Manchester Operations Supervisor communication structure.

Deputy Traffic Manager

The Deputy Traffic Manager is one of two managerial heads of the Manchester Tower and TRACON facilities. The Deputy Traffic Manager participates in the Northeast Region teleconference in which any pertinent traffic management information from the floor is communicated to him through the Operations Supervisor, and information retrieved from the teleconference is then relayed back to the Operations Supervisor. The Deputy Traffic

Manager also participates in other teleconferences including other air traffic regions throughout the morning, and often the Operations Supervisor receives pertinent strategic information from these teleconferences as well. The Operations Supervisor communicates with the Deputy Traffic Manager approximately twice per day.

Manchester Tower and TRACON Controllers

The Manchester Tower and TRACON controllers perform the interactions with the aircraft in the Manchester airspace. It is the job of the Operations Supervisor to ensure that no sector will become overloaded with aircraft, so he or she must constantly monitor the radar scopes and the behaviors that the individual controllers are exhibiting for signs of high workload.

Flight Data Coordinator

The Flight Data Coordinators for the Tower and the TRACON must retrieve the GI messages (see Appendix A) from the printer and enter them into the IDS-4 system (see Appendix A) for the sector controllers to read. The Operations Supervisor communicates constantly with the Flight Data Coordinators to ensure that he or she is up to date on each restriction that enters the facility.

Boston Center & Boston TRACON

Boston Center and Boston TRACON TMCs represent the adjacent facilities to Manchester airspace. One of the major ways that Manchester facility receives information about traffic initiatives is through phone conversations with Boston Center and Boston TRACON. The Operations Supervisor emphasized that this was the most effective and immediate way of sending and receiving strategic traffic information. The new and revised restrictions are also sent through the FDIO/GI Message System (see Appendix A) to Manchester from Boston Center.

Once per day a Northeast Region teleconference occurs that discusses the previous day's traffic initiative, and determines what initiatives worked and why other initiatives did not work. The different parties participating in this teleconference are Boston Center TMC, Boston TRACON TMO, Manchester Deputy Traffic Manager, and other small tower facilities.

Manchester Airport Authority

The Manchester Airport Authority ensures that the equipment and runways at Manchester airport are maintained. The Operations Supervisor keeps in touch with this group throughout the day to coordinate maintenance needed on the runways or to arrange other airport functions that may interfere with the air traffic operation.

National Weather Service (Taunton, NH)

The National Weather Service provides current weather information or weather forecasts upon request. When the forecasts received from the TRACON or the Center are conflicting, the Operations Supervisor may call the NWS for a weather forecast. Much of the information on current weather is communicated through the Doppler weather radar displays located in the Tower and TRACON areas (see Appendix A).

3.4.1.2 Communications and coordination problems

The Operations Supervisor mentioned several communications problems that the facility experienced on an everyday basis during the interview. Among these were:

Difficulty in reaching the Boston Center over the telephone: In some of the busier periods, the Manchester supervisors had difficulty in reaching the Boston Center over the telephone. Often they would have to telephone Boston TRACON to get the TRACON to relay Manchester's problem to the Center. The Operations Supervisor said that the Center would be more likely to answer a call from the TRACON due to the Boston terminal area's greater impact on the Center traffic compared to any of the smaller facilities.

Information about GDPs not communicated in a timely fashion to smaller towers: According to the Operations Supervisor, the Boston Center fails to communicate the end of a Ground Delay Program (GDP) in a timely fashion to the smaller towers. In a GDP, all terminal facilities have to be given a release time for each aircraft departing for an airport in which a GDP was in effect. Often a GDP would last 2-4 hours and when the airport was able to accept the normal stream of traffic, the Command Center would tell the Centers, and the Centers would then let the individual towers know through the use of the GI message. At Manchester, the Operations Supervisor felt that the controllers at the facility were not notified of the end of a GDP fast enough. Often, he said, the airline pilots departing knew of the end of a GDP before the controllers knew. In that case, the controllers used a "trust and verify" method in which they approve the clearance to release the aircraft, and then telephone the Center to determine if the initiative has actually ended.

Assigning "inefficient" routes to aircraft to avoid spending time coordinating with other facilities to achieve a more direct route: Another coordination problem that the controllers face is the necessity to assign more "inefficient" routes to aircraft to cut down on coordination time spent to achieve the most direct route. For example, often when an aircraft is on a Boston arrival route from the northwest and a storm passes through the area, the Center controllers will give the aircraft a SCUPP (northeast) arrival route rather than having to coordinate with Manchester facility to achieve a more direct route.

Lack of flexibility in Boston Center's metering program: One traffic management concern that the Manchester Operations Supervisor expressed was the lack of flexibility available to the Boston Center metering program. This metering program allowed the Center feeder controller to Boston TRACON to set miles-in-trail restrictions on aircraft executing arrivals into Boston TRACON. The program would display to the Center controller what time each aircraft would need to be over the feeder fix to give that specified miles in trail using aircraft performance information and software algorithms. While usually effective, the aging algorithms and inaccurate aircraft performance information merely provides an estimate of the time to give the appropriate miles-in-trail required by the TRACON. Often in times when the arrival load is lighter in the TRACON, the TRACON controller might quickly acquire a couple of aircraft from the Center, making the metering algorithms obsolete for a period of time. This inflexibility negatively affects the efficient arrival streams into Boston TRACON, according to the Operations Supervisor.

3.4.1.3 Suggestions for improved communications/coordination

The Operations Supervisor provided suggestions to improve communication and coordination from the perspective of Manchester facility:

Combine Boston TRACON and the Manchester TRACON into one facility: This would reduce inter-facility coordination efforts that exist today. This combination of TRACONs is already in the process of becoming a reality in the next few years.

Consolidate the information network into one system: A single information-sharing system would quickly pass traffic initiatives from the Command Center down to the small terminal facilities without the complications added by three people typing the same information into separate systems. This way, the most current information can be available as quickly as possible to even the lowest branches of the air traffic control system.

3.4.1.4 Additional observations

In discussions with the Operations Supervisor, it was discovered that Boston Center was occasionally able to absorb departures to a restricted airport, even during a GDP program.

Negotiation under high workload

According to the Operations Supervisor, there is a certain amount of flexibility involved in releasing aircraft, even if a GDP is implemented. The tower controller can sometimes contact the Boston Center TMU directly to determine if an earlier departure can be arranged. Such a negotiation over departure time is not even pursued if the Operations Supervisor observes that controllers at a facility further down the line is already "spinning" aircraft, signaling that controllers' level of workload is high.

Chapter 4

Results of Site Visits - New York

Presented below are the results of the focused interviews and the field observations performed at the New York air traffic control facilities. Included in the results from each position is a detailed communication and coordination structure for that position, the information tools utilized, the problems that the position found in the communication and coordination associated with the position, and any other pertinent observations.

4.1 New York Center (ZNY)

The New York Center facility is located on Long Island and has the responsibility of maintaining safety and efficiency within some of the most complicated and saturated airspace in the nation. Half of the facility is dedicated to the domestic airspace, and half is dedicated to oceanic operations in the north and west Atlantic Ocean. In Figure 4.1, the mainland airspace under the control of New York Center is depicted.

In the western division of the Center's airspace, there are four of the busiest airports in the NAS: John F. Kennedy International Airport, La Guardia Airport, Newark International Airport, and Teterboro Airport (hosting the business jet traffic into the New York metro area). A diagram of the New York metro area is shown in Figure 4.2.

Pictured in Figure 4.3 is a communication structure for the New York Center. Similar to the TMO position at Boston, the Traffic Management Officer is the acting head of the New York Center who is supported by the Traffic Management Unit.

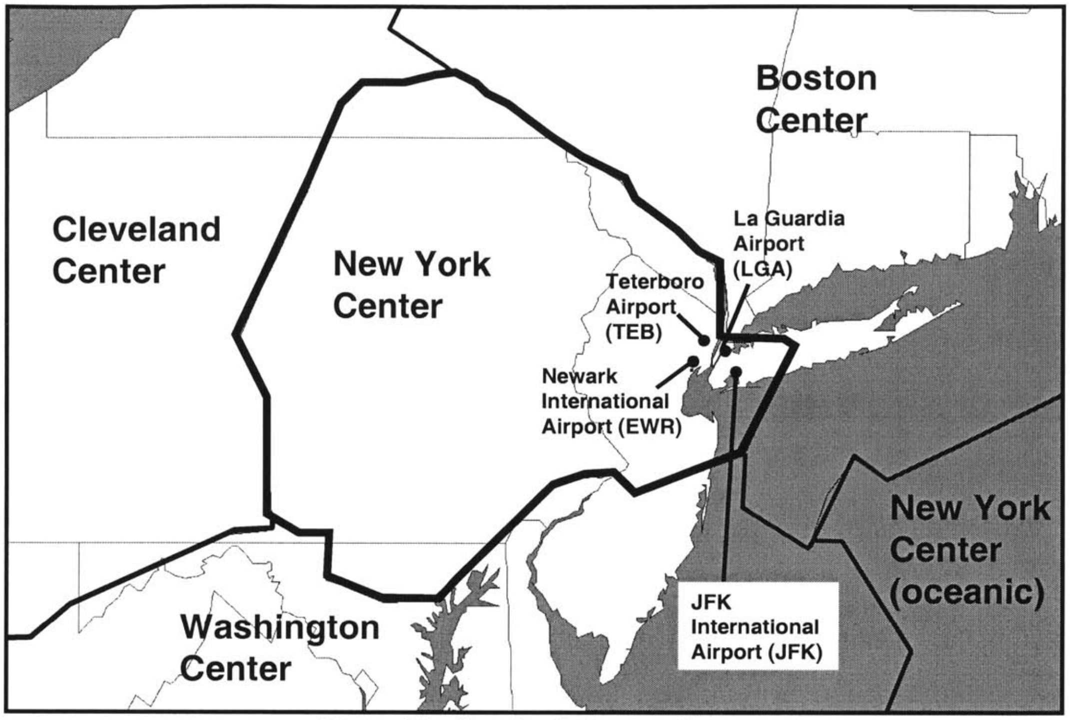

Figure 4.1: New York Center airspace

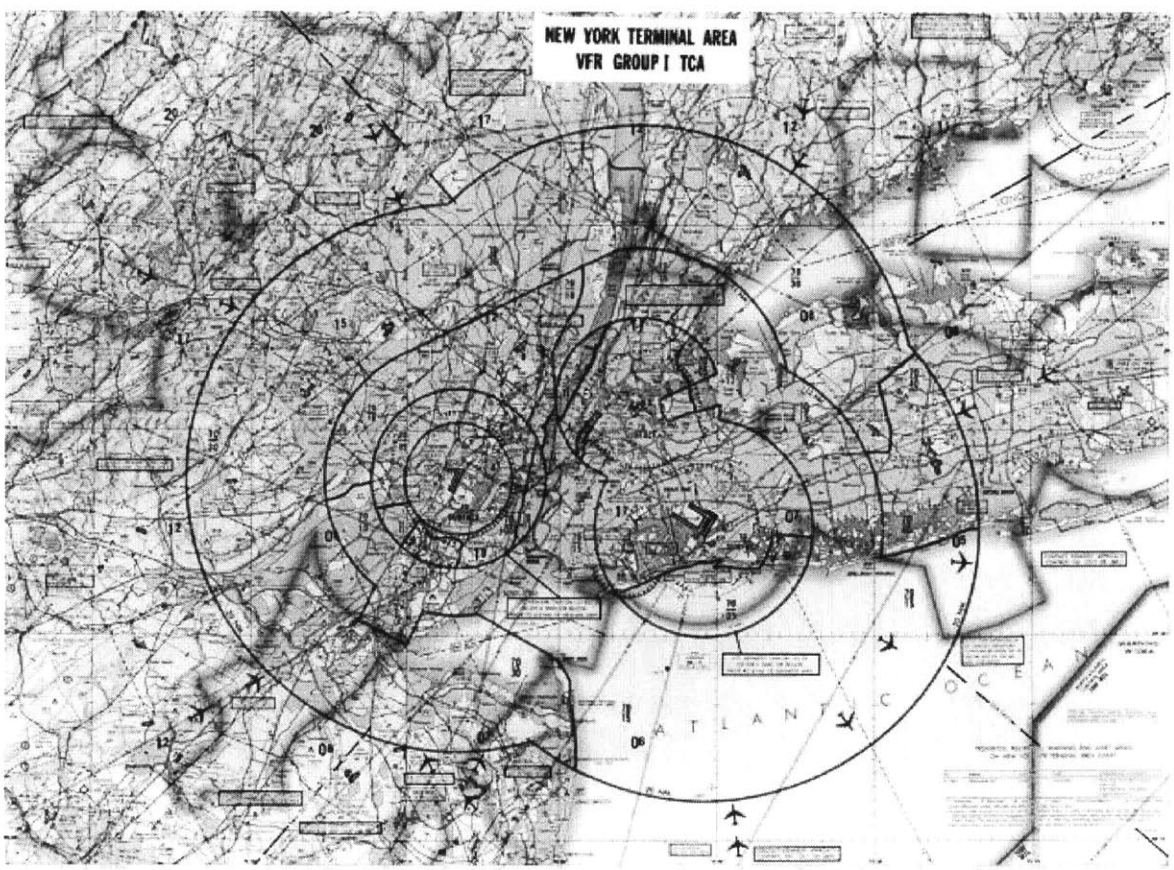

Figure 4.2: New York metro area airspace

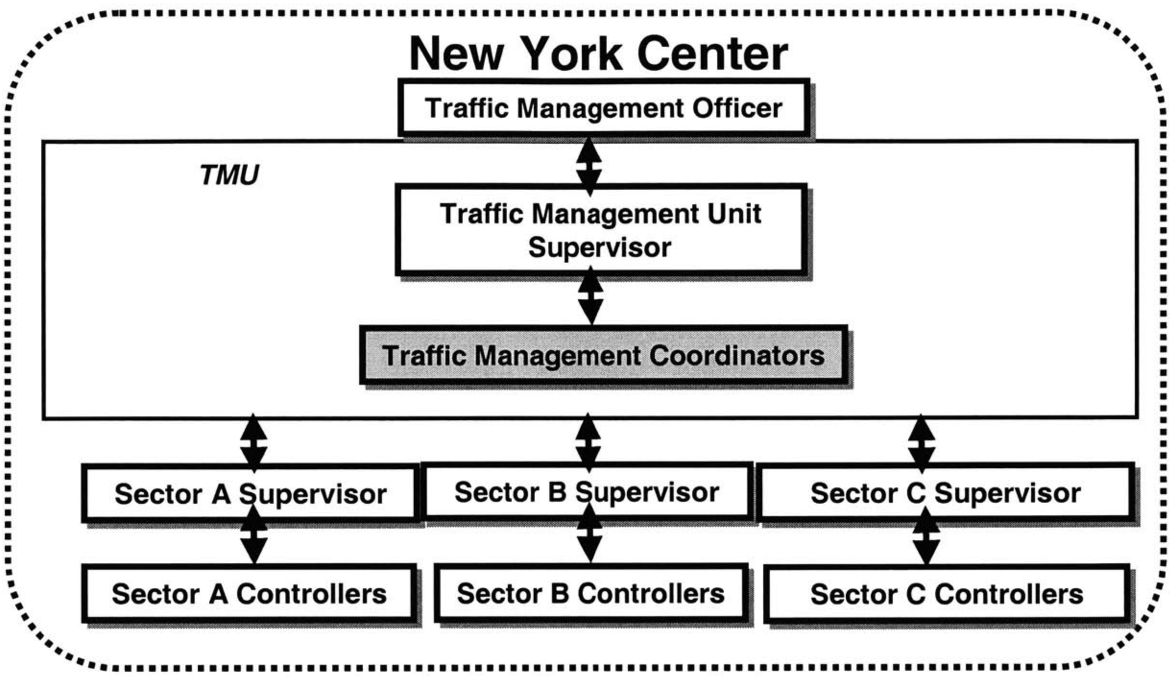

Figure 4.3: New York Center communication structure.

4.1.1 New York Center Traffic Management Coordinator

There are approximately 3-6 Traffic Management Coordinators (TMCs) in the Traffic Management Unit in the New York Center during the day. The functions of the New York TMC are as follows:

- Monitor state of tactical controllers through sector supervisor updates to ensure that no sector is overloaded with aircraft
- Determine when a traffic initiative should be imposed on traffic into or out of New York Center
- Communicate restrictions from other facilities that affect traffic into or out of New York Center to the sector supervisors to be implemented by the tactical controllers
- Advise TMO on what strategic traffic measures should be taken before teleconferences and why

The TMCs at New York Center are assigned specialized duties to perform. These duties are:

- Operations Manager: performs as representative of the NY Center on mandatory Command Center teleconferences every two hours and relays pertinent information back to the TMU.
- Departure Director: responsible for ensuring efficient flows out of New York airspace and meeting restrictions imposed on New York from adjacent facilities.
- Arrival Director: (may be combined with other duty during slow periods) responsible for enacting traffic initiatives to control flows into New York airspace.
- Shift Coordinator: responsible for ensuring that staffing at the Center is adequate for the expected traffic demands.
- Monitor Alert Coordinator: responsible for monitoring sector alert on the Enhanced Traffic Management System. If a red-alert is issued over two consecutive 15-minute periods in a sector, that sector supervisor must be consulted to resolve the controller overload potential.

4.1.1.1 Communication and coordination structure

The communication and coordination structure provided in Figure 4.4 was elicited from the TMCs interviewed. Below the figure is a description of the individual communications between the New York Center TMC and other parties.

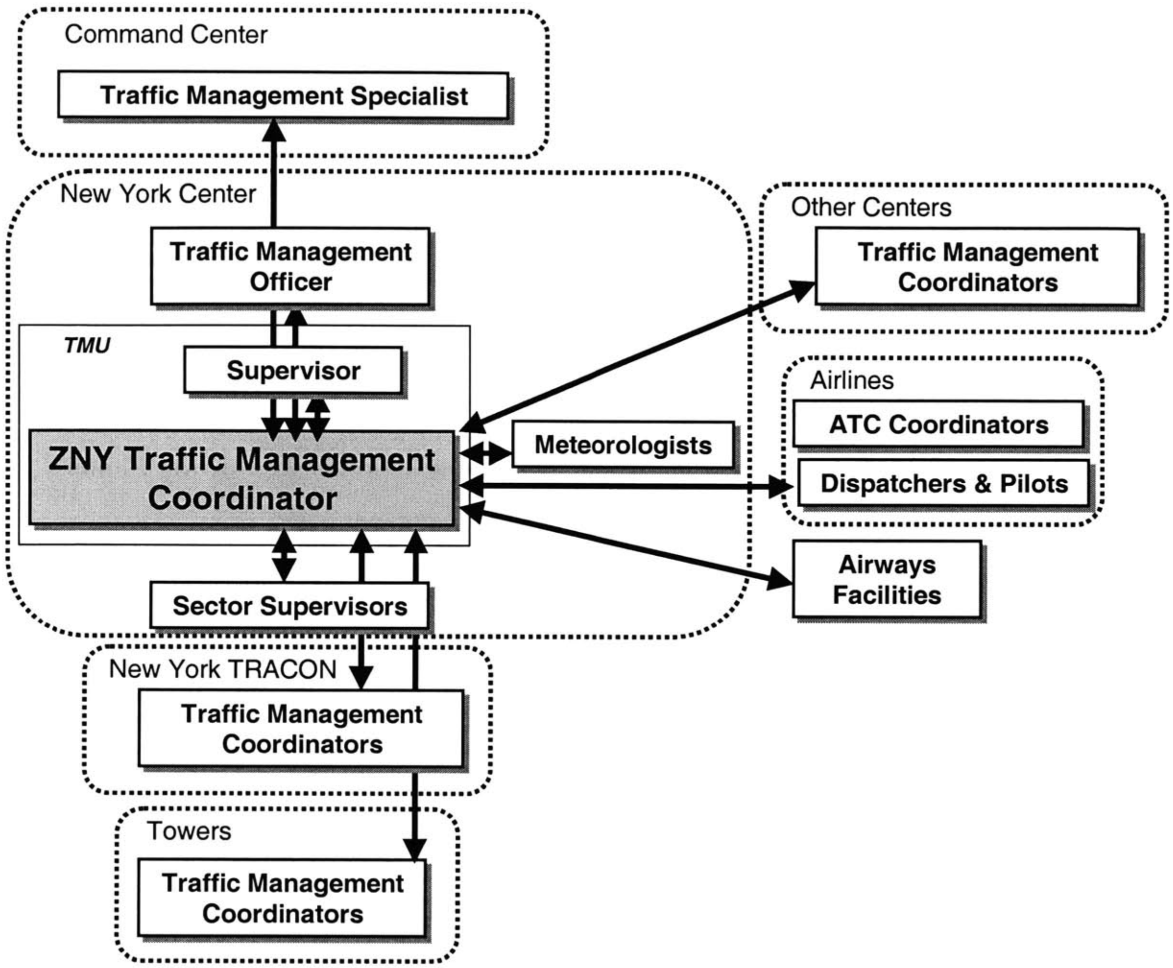

Figure 4.4: New York Center TMC communication structure.

Command Center Traffic Management Specialist

The Command Center TMS is responsible for ensuring that the New York facilities are performing at maximum capacity to minimize negative effects on the rest of the nation's air traffic. Most of the TMC's communications with the Command Center are through teleconferences, which occur every two hours. One-on-one telephone conversations may also occur with the TMS from the Command Center to solve a particular problem more in-depth than can happen in a teleconference. The TMSs often telephone the TMCs to ask particular questions about procedures or predicted traffic demand that help them maintain a better picture of the situation.

New York Center Traffic Management Officer

The Center TMO is the managerial head of the New York Center. The TMC communicates with the Traffic Management Officer (TMO) both to update the TMO with the current status of the traffic flows and to retrieve information from teleconferences in which the TMO participates.

New York Center TMU Supervisor

The Center TMU Supervisor is responsible for the actions taken by the Center TMU and strives to maintain efficiency of the facility while protecting the tactical controllers in the facility from overload. Before making any strategic traffic management decisions, the TMC must first consult the Supervisor. Face-to-face communication occurs frequently upon request by both parties, which are located in the TMU area.

New York Center Sector Supervisors

The Sector Supervisors are responsible for monitoring the traffic load experienced by the tactical controllers within their assigned sectors and advising the Center TMU when a traffic initiative is needed. Since one of the TMC's functions is to maintain a current image of the situation from the tactical controllers' point of view, the TMC is often visiting the Sector Supervisors. The conversations consist of the TMC relaying new or ending traffic restrictions to the Sector Supervisors, or they could consist of the TMC warning the Sector Supervisor of an impending traffic rush on a sector as predicted by the ETMS Monitor/Alert (see Appendix A).

New York Center Meteorology Unit

The TMC's weather forecasts are obtained from the facility weather unit, and they may be consulted in short face-to-face meetings throughout the day to make predictions about what weather may be developing. Current weather is often obtained from the meteorologists in conjunction with the Doppler weather radar (see Appendix A for more information).

New York TRACON TMCs

The TRACON TMCs are responsible for maintaining efficiency within the New York TRACON while protecting the tactical controllers in the TRACON from traffic overload. The Center TMCs are often in contact with the TRACON TMCs due to the Center's dependence on the TRACON for much of the departure demand. Often these communications occur by telephone, but they can also be communicated electronically through the Departure Spacing Planner (see Appendix A for more information).

New York Tower TMCs

Tower TMCs are responsible for maintaining efficiency of the Tower facility while protecting the tower controllers from overload due to too many arrivals. Making decisions about the arrival flows and departure flows is highly dependent on the acceptance and departure rates of the four major airports. Often these rates can be retrieved from the Command Center website, but they may not be updated to the most recent runway configuration, so telephone is often the means of reaching the Towers. Center TMCs are able to monitor the predicted departures from the towers using the Departure Spacing Planner tool (see Appendix A).

Other Centers' TMCs

The New York Center TMCs often contact other Centers such as Washington, Boston, and Cleveland by telephone to negotiate specific re-routes or inquire to reasoning behind restrictions. The TMCs said that the communication between Centers has been decreased a lot since the Command Center has become more of a centralizing force, but those communications were then replaced with time spent in teleconferences.

Airway facilities

The airway facilities are contacted by telephone if an airport is under construction or undergoing maintenance that affect the operations. The TMCs may ask for an estimate of how long until the construction/maintenance is complete and operations can return to normal.

Airline ATC Coordinators

Airline ATC Coordinators are employees of the airlines that are often retired controllers who aid the airlines in communicating with ATC about traffic management issues. Much of the communication with the airlines is through phone conversations with the ATC coordinator. The ATC Coordinator may telephone the Center to ask about a particular flight or group of flights. Much of the negotiation with the airlines about traffic restrictions occurs during teleconferences in which the Command Center gathers information from the Center and the airline, and then makes a decision that will be fair to both parties. The TMC also uses the ETMS Traffic Situation Display and the Flight Schedule Monitor to determine current and predicted traffic demand from the airlines (see Appendix A for more information).

4.1.1.2 Communication and coordination problems

The New York Center TMC expressed several communications concerns regarding the position of TMC:

Difficulty conveying a need for a facility restriction to the Command Center because different sets of information are being used to predict sector workload at the Center: The Command Center only uses the ETMS Sector Monitor/Alert function to predict workload, while the TMCs at the Center also use radar scopes and their experience working the sector to determine when the sector will be busy. The ETMS Sector Monitor/Alert often gives false data alerts, predicting high workload which may not occur or vice versa that the TMCs can discriminate using other sources of information. The Command Center has only the ETMS, so they place more value on this tool's information than may be warranted in reality.

Collaborative Decision Making (CDM) involves too many people, and it breaks down the Center's authority over the Towers and the TRACON: The TMCs said that the multiple teleconferences associated with CDM are not efficient, because much of the information passed does not need to be known by certain facilities. "The Towers don't need to know the weather down in Kansas to release aircraft, they're just supposed to give us the aircraft and we'll figure out the weather," said one New York TMC.

The hotline is failing because it is not proceduralized enough, and information is not getting to the right people: According to the TMC interviewed, TMCs are used to following strict procedures, but the hotline is not proceduralized at all. People are not talking to each other efficiently, and too many lines of communication are open at one time. Two or three TMCs can be talking on separate lines about the same issue.

The role of the Command Center is making the air traffic situation worse, not better: Since the Command Center was given the responsibility of the national traffic management, the inter-facility communication has increased. The Command Center does not have the authority to "force" a facility to accept a traffic initiative, therefore the Centers still have the final word. More time is spent on justifying the need for an initiative to the Command Center, and it can sometimes reach 25-60 minutes on the telephone. The TMC responded that the Command Center seems to be disorganized as well, because often the Severe Weather group does not know what the East is doing and vice versa.

Implementing an initiative is slow: The implementation of traffic initiatives is slow because of the large amount of coordination required among the facilities and the airlines to get it approved.

The ATC system is having problems resolving its responsibility to ensure safety while maintaining efficiency: The innate problem of two very different responsibilities makes it difficult for a TMC to prioritize his or her duties.

The current ATC structure (a collaborative environment) conflicts with the TMC's understanding of the system as a controller, which has been historically hierarchical: Since many controllers come from a military background, they are used to having a very solid concept of their place in the hierarchical structure of their work environment. By giving Towers and TRACONs equal input as the Centers, the TMCs are losing their understanding of where they fit in the hierarchy, if one exists in today's ATC environment.

4.1.1.3 Suggestions for improved communications/coordination

The New York Center TMC also provided some suggestions for improving the communication and coordination:

Impose procedure on the hotline communications: By segmenting the hotline into "arrivals only" or "departures only," it is more clear to TMCs what information is originating from where. In addition, it is more likely to be a more organized flow of information to the tactical controllers if the strategic communications are more proceduralized.

There should be a clear ATC structure so that the TMCs are aware of their authority, or lack thereof: If the FAA is advocating a collaborative environment with the Command Center in command, then authority should be designated to the Command Center to be able to enforce decisions made. Otherwise, the Command Center is just adding unnecessary inter-facility coordination, and many of the issues with traffic management could be arranged between Centers.

The ATC system should be semi-privatized: Because of the two disjointed roles of ATC to maintain safety and efficiency, neither role is accomplished to its full extent. By assigning one of the responsibilities to a private organization, the TMCs could concentrate on the task assigned to them.

4.1.1.4 Additional observations

During the site visit to New York Center, the TMCs discussed topics relating to acquiring approval for a traffic initiative from the Command Center, the reasons behind New York's inundation with traffic restrictions, and the process of flight plan information transfer. Below, the results of these discussions are presented.

How Center TMCs get approval from the Command Center for a traffic initiative

Most of the time, the Center TMC will telephone the Command Center TMS to request a traffic initiative—it is usually approved given appropriate justification. On occasion, the Command Center Traffic Management Specialist may not approve a traffic initiative that is needed by the New York Center. If the Center TMC feels that the initiative is justified, then he or she may proceed to approach the East Supervisor at the Command Center with the issue. Since the East Supervisor is higher in the chain of command, he may choose to overrule the decision of the TMS and allow the traffic initiative or not. If the decision from the East Supervisor is to reject the traffic initiative, the Center TMCs will attempt to control the traffic through internal measures; if the traffic persists, a Ground Stop will be implemented.

Reason for New York restrictions

Many of the restrictions affecting New York do not originate from the New York facilities, but from the adjacent facilities seeking to control the flow into their facility from New York. There is little airspace in the New York Center to absorb these Miles in Trail restrictions, so they have to be passed back to the New York TRACON.

Another reason is that airlines do not schedule responsibly. To be a successful TMC at New York, the flows must be balanced so that all the aircraft are not "flushed out at once" encouraging a ground stop.

Flight plan information transfer

In the area of the New York Center called "The Pit", flight plans for departing aircraft in the metro area are adjusted and cleared before being sent to the Towers. During low traffic periods, two traffic managers are assigned to Pit duties, each taking responsibility for half of the airports' departing aircraft flight plans. In busier periods, up to five people can be handling flight plan duties.

Once the flight plan information is passed to the New York Host computer system, the flight plan appears on the DSP screen in the "Proposed" bin. This occurs approximately 45 minutes before the aircraft is scheduled to depart. The Pit traffic manager then checks the flight plan for compatibility with preferential routing, determined by valid departure fix and airway (assigned by computer applied routings or preferential departure routes).

If the flight plan is not compatible, then it is changed by the Pit traffic manager to reflect the preferential routing, and then sent to the "Cleared" bin to be used by the Tower controllers. In addition, any changes made to the flight plan within 15 minutes of that aircraft departing are telephoned to the Tower as well.

4.2 New York TRACON (N90)

Responsible for integrating the four major New York airports' traffic into an organized departure flow or separate arrival flows, the New York TRACON functions more like a Center than a normal TRACON. The facility is broken into areas that reflect the various traffic flows, which can be seen in Figure 4.5. Unlike Boston TRACON, who assigns one controller per area, New York may have 5-10 controllers per area. The Islip area handles arrivals into Islip Airport and other Long Island airports. The La Guardia area handles La Guardia Airport arrivals as well as arrivals into White Plains Airport, Danbury Airport, and others. The JFK area controls arrivals into John F. Kennedy International Airport, and the Newark area handles arrivals into Newark Airport. The Liberty area handles all of the departures that leave the New York metro area. The Traffic Management Unit is positioned close to the Newark and Liberty sectors due to the fact that so many of the initiatives arranged by the TMCs affect those sectors.

In Figure 4.6 below, the communication structure of the New York TRACON is presented. Interviews and observations were performed at the Traffic Management Coordinator position, which is highlighted in the figure.

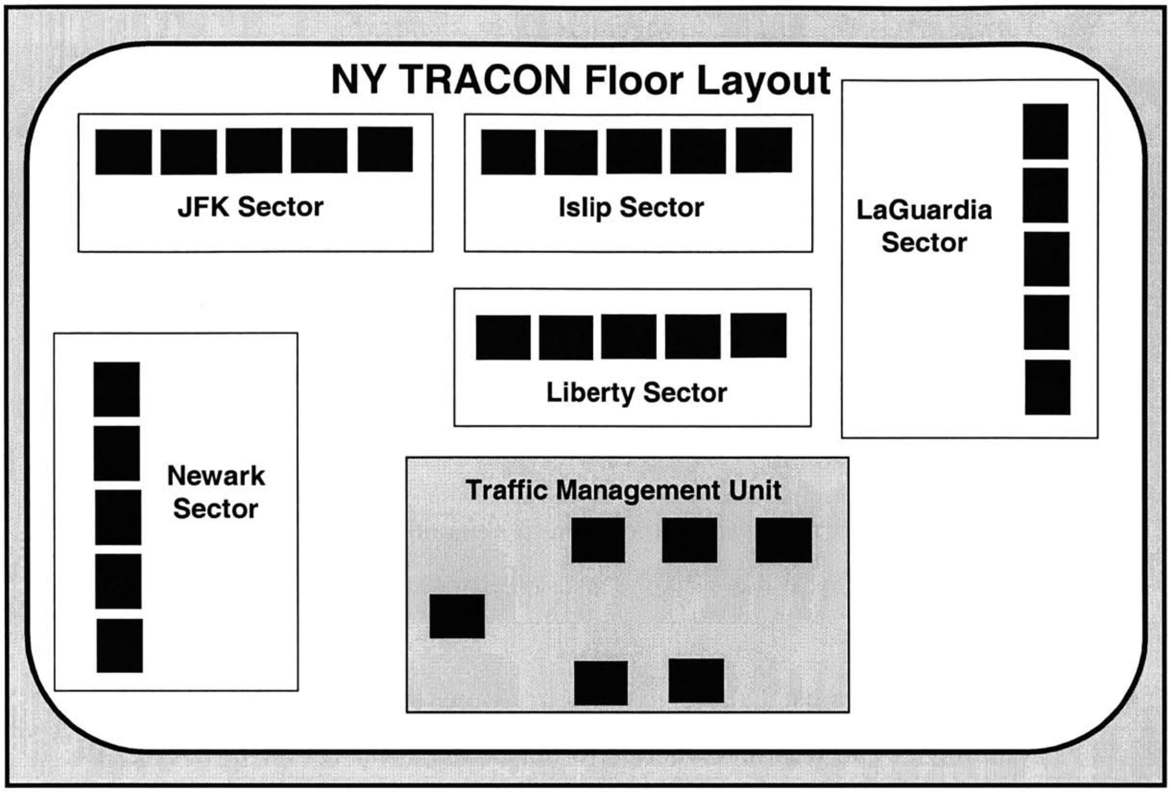

Figure 4.5: New York TRACON floor layout schematic.

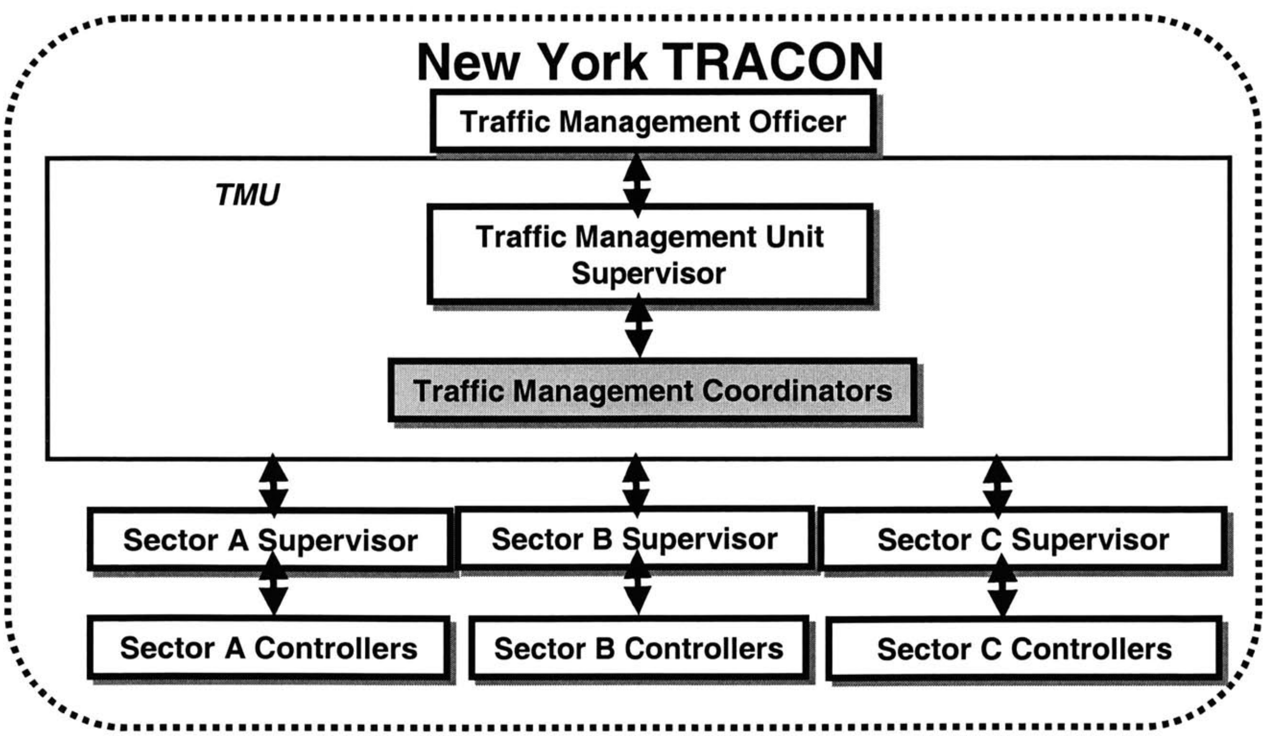

Figure 4.6: New York TRACON communication structure.

4.2.1 New York TRACON Traffic Management Coordinator

At the New York TRACON, there are 3-8 Traffic Management Coordinators on duty at any time. The functions of these TMCs are to:

- Monitor state of tactical controllers to ensure that no sector is overloaded with aircraft
- Determine when a traffic initiative should be put on traffic into or out of New York TRACON
- Communicate restrictions from other facilities that affect traffic into or out of New York TRACON to the TRACON supervisor and the tactical controllers to be implemented
- Advise the TMO on what strategic traffic measures should be taken before teleconferences and why and what performance to expect out of the TRACON during a particular day

4.2.1.1 Communication and coordination structure

The communication and coordination structure provided in Figure 4.7 was elicited from the TMCs interviewed. The individual communication between the New York TRACON TMC and each party is also discussed.

Command Center Traffic Management Specialist

The Command Center TMS is responsible for ensuring that the New York facilities are performing at their maximum capacity to minimize negative effect on national air traffic. Many of the communications that occur are initiated by the Command Center to check the current status of the TRACON. The New York TRACON TMC communicates with the Command Center TMS approximately 15-20 times per day on average.

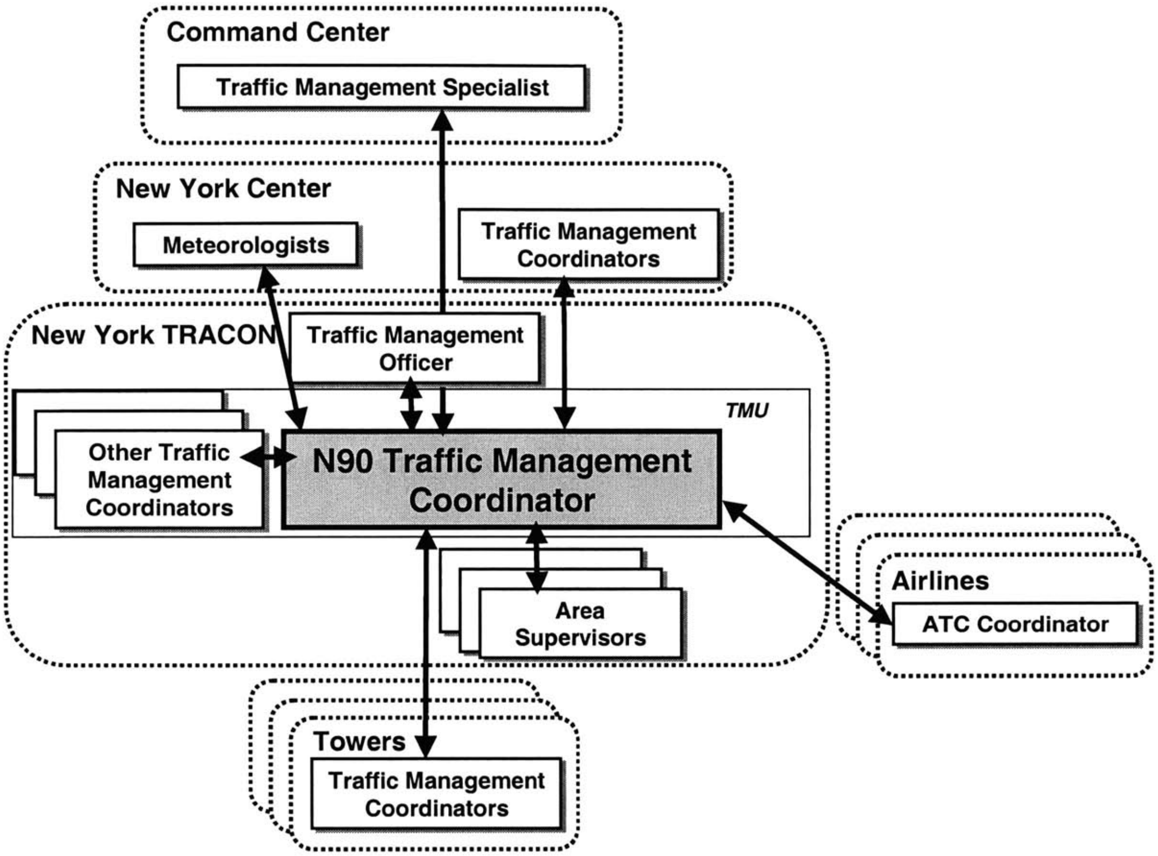

Figure 4.7: New York TRACON TMC communication structure.

New York Center Meteorologists

The Center meteorologists broadcast weather forecasts through two telephone calls each day to the TRACONs and Towers in the New York area accompanied by an electronic version of the forecasts. If the weather changes between these two times, the TRACON TMC might telephone the Center meteorologists to get a current update. Much of the information on the current weather is communicated through the Doppler weather radar displays located in the TMO office, the TMU area, and near each Sector Supervisor (see Appendix A for more information). The Integrated Terminal Weather System (ITWS) is used frequently by the TRACON to gather information on the thunderstorm activity that affects the traffic flows, especially during the summer months.

New York Center Traffic Management Coordinators

The Center TMCs are responsible for ensuring that the Center is performing efficiently, while preventing the traffic load from overloading the Center controllers. The telephone conversations are initiated by the TRACON when a traffic initiative is needed to limit arrivals into the TRACON. Center TMCs telephone the TRACON to limit the departure flow from the TRACON into the Center. TRACON TMCs communicate with the Center TMCs 3-4 times per hour mostly over the telephone, but also through the computer. Twice per day an electronic version of all traffic initiatives affecting the TRACON's airspace is sent from the Center TMCs to the TRACON TMCs to pass on to the areas and Towers to implement.

New York TRACON Traffic Management Officer

The TRACON TMO is the managerial head of the New York TRACON. The contact with the Traffic Management Officer is limited, usually consisting of one face-to-face conversation each day to update the TMO on the TRACON situation before the morning teleconference.

Other TRACON Traffic Management Coordinators

There are 5-7 TRACON TMCs who are jointly responsible for the safety and efficiency of the New York TRACON. There is constant coordination among the TMCs at the TRACON due to the need of each person to be kept updated on each situation arising that may affect the TRACON flows. Much of the communication is spoken, but information like the current restrictions are posted on the TRACON TMU white board (see Appendix A).

New York TRACON Area Supervisors

The Area Supervisors are responsible for monitoring the traffic load affecting the controllers in their assigned area and notifying the TRACON TMCs if a traffic initiative is needed. The TRACON TMCs communicate constantly with the TRACON Area Supervisors to ensure that all restrictions on the TRACON are implemented and to gauge feedback on the workload of the individual controllers in the areas.

Airline ATC Coordinators

Airline ATC Coordinators are employees of the airlines that are often retired controllers who aid the airlines in communicating with ATC about traffic management issues. The ATC Coordinators contact the TRACON TMCs on the average of about twice per day by telephone. Many of these conversations are to determine the status of TRACON restrictions or to inquire about a particular aircraft's route.

Tower Traffic Management Coordinators

The Tower TMCs are responsible for the maintaining efficiency of departures and arrivals while preventing the Tower controllers from becoming overloaded with arrivals. The TRACON TMCs communicate with the Tower TMCs constantly. Many of the communications involve the Tower TMCs calling the TRACON to request approval to release aircraft for departure. The TRACON TMCs also send electronic forms containing the current traffic initiatives in effect twice per day to the Towers. TRACON TMCs are able to monitor the predicted departures from the towers using the Departure Spacing Planner tool (see Appendix A). The TRACON TMCs configured one monitor in the TMU to display the Traffic Count Automation Program (TCAP), which provides hourly counts of traffic into and out of each airport. This is considered especially useful to the TMCs since the ability to anticipate flow problems into and out of the major airports is a critical task.

4.2.1.2 Communication and coordination problems

The New York TRACON TMC reported several communication and coordination problems that were experienced:

Communication equipment is inappropriate for the TMC position: Currently the TRACON TMCs are using aging, stationary telephone equipment to perform their communications tasks. Since so much of the TMC's time is spent in communications tasks that require them to remain at the desks due to the equipment limitations, the TMC task of monitoring the floor controllers is often shed.

New York TRACON TMCs do not have enough input into Command Center decisions: The TRACON TMCs are usually consulted before decisions are made by the Command Center regarding the New York airspace. However, the TMCs responded that they would like more input into departure restrictions, arrival rates, and arrival restrictions that affect the New York TRACON.

The Command Center TMSs are not familiar enough with the New York airspace: The Command Center often rotates the TMSs so that each person becomes exposed to different types of airspace within the East or West regions. It is not unusual for a TMS in charge of the New York area to have never worked at a New York facility before. This presents complications for the New York TRACON TMC, who then must explain why a certain traffic initiative is needed to an inexperienced TMS.

Not enough interaction between New York TRACON TMCs and the floor controllers at the New York TRACON: Due to the limited amount of TRACON TMCs on duty at any one time, there is too little interaction between the TMCs and the TRACON floor controllers.

TRACON TMCs need more information about the arrival and departure flows at Newark Airport: The New York TRACON TMCs are constantly concerned with minimizing the delays at all of the New York airports. Because Newark Airport has had greater delays, historically, than the rest of the airports, the TRACON TMCs are interested in getting the most information about the status of the airport to minimize any delay situations that may arise at Newark.

4.2.1.3 Suggestions for improved communications/coordination

In addition to the problems that they had, the New York TRACON TMCs also provided some suggestions for improving the coordination:

Improve communication equipment: The telephone equipment is not adequate for the needs of the TRACON TMCs. To be able to adequately communicate with the Towers and other facilities as well as monitor the workload of the floor controllers, the TMCs need a hands-free and wireless communication system that allows unlimited movement.

Increase input into Command Center decisions: While generally consulted when implementing high-level traffic initiatives affecting the TRACON, the TRACON TMCs would like more input on departure restrictions, arrival rates, and arrival restrictions.

Familiarize Command Center Traffic Management Specialists (TMSs) with New York airspace and procedures: The inexperienced TMSs should be required to complete at least one visit per year to each of the facilities in which they work. These visits encourage understanding of procedures at the facility as well as constraints that the facility may face on a daily basis due to airspace, traffic or environmental factors.

Increase interaction with floor controllers: Because the position of TRACON TMC is so demanding, often the task of monitoring the floor controllers is shed. The TMCs therefore need more time to spend on the floor, predicting the needs of the tactical controllers.

Redistribute New York airspace: The New York Center and TRACON is currently unable to absorb any restrictions placed on them by Cleveland, Washington, or Boston Centers due to the lack of adequate airspace. Because of this, any restriction put on New York Center almost automatically gets passed to the individual Tower departures, removing any intra-facility flexibility within the New York facilities.

- *Current plan:* Provide a 360 degree airspace around the New York metro area and combine New York Center and New York TRACON into one facility.
- *Benefits:*

- More traffic can be absorbed internally.
- Communication between facilities is eliminated, making the coordination more efficient.
- Reduces noise through implementation of Standard Instrument Departures (SIDS).
- Provide more efficient routes for aircraft through straight-line VOR routings.
- Conversion to airspace grid system to enable more accurate position information.
- Conversion to a standard 4-cornerpost design for arrivals and departures to and from all three major airports.

4.2.1.4 Additional observations

During the interview with the New York TRACON TMC, he provided a list of attributes that are considered critical to perform the TMC position successfully. This discussion is described below.

Traits of a successful New York TRACON TMC

When interviewed, the TRACON TMCs provided a list of certain professional and personal traits that were discovered to reflect a successful TMC. A good New York TRACON TMC will be familiar with the sectors in the TRACON and the airports in the New York area. The TMC will also have a complete understanding of the New York airspace and how his actions affect everyone else. The TMC will be able to relate well to people, is flexible, and can readily assess the needs of the other person.

4.3 Newark Tower (EWR)

Newark Airport is one of the NAS's most busy and most delayed airports. Because of this reputation, the Newark Tower is put under significant pressures to maintain constant flows into and out of the airport. As reported by the New York TRACON TMCs, this is the airport in the New York metro area that requires the most

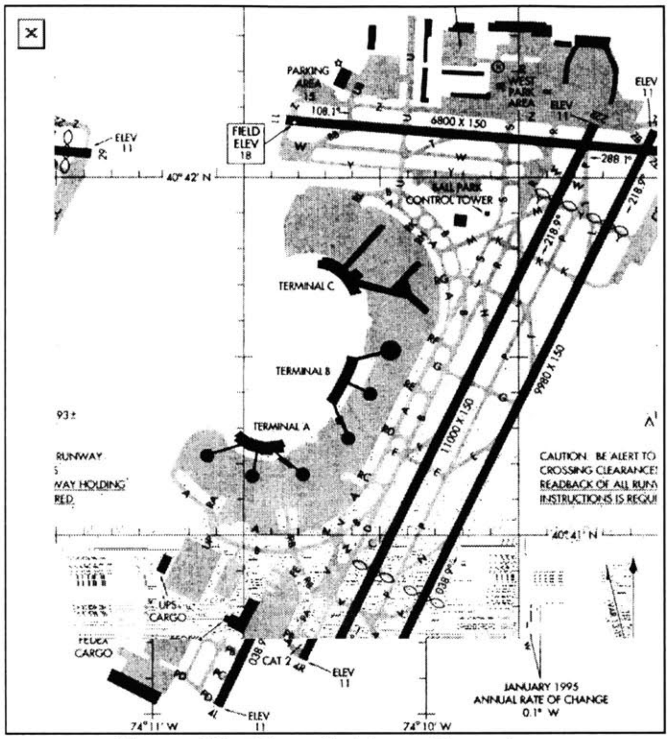

Figure 4.8: Newark Airport layout.

monitoring due to its unpredictable dynamics. As can be seen in Figure 4.8, the limited runway space available at Newark often constrains operations at the Tower.

4.3.1 Newark Tower Traffic Management Coordinator

At the Newark Tower, there is a single Traffic Management Coordinator on duty during the day. The functions of this TMC are to:

- Monitor state of tactical controllers to ensure that the Tower is not overloaded with arriving aircraft
- Determine when a traffic initiative should be put on traffic into Newark
- Communicate restrictions from other facilities that affect traffic into or out of Newark to the Tower supervisor and the tactical controllers to be implemented
- Advise TMO on what strategic traffic measures should be taken before teleconferences and why and what performance to expect out of the Tower during a particular day

4.3.1.1 Communication and coordination structure

The communication and coordination structure provided in Figure 4.9 was elicited from the TMC interviewed. Below the communication structure is an in-depth discussion of the various individual communications that the Newark TMC has with other parties.

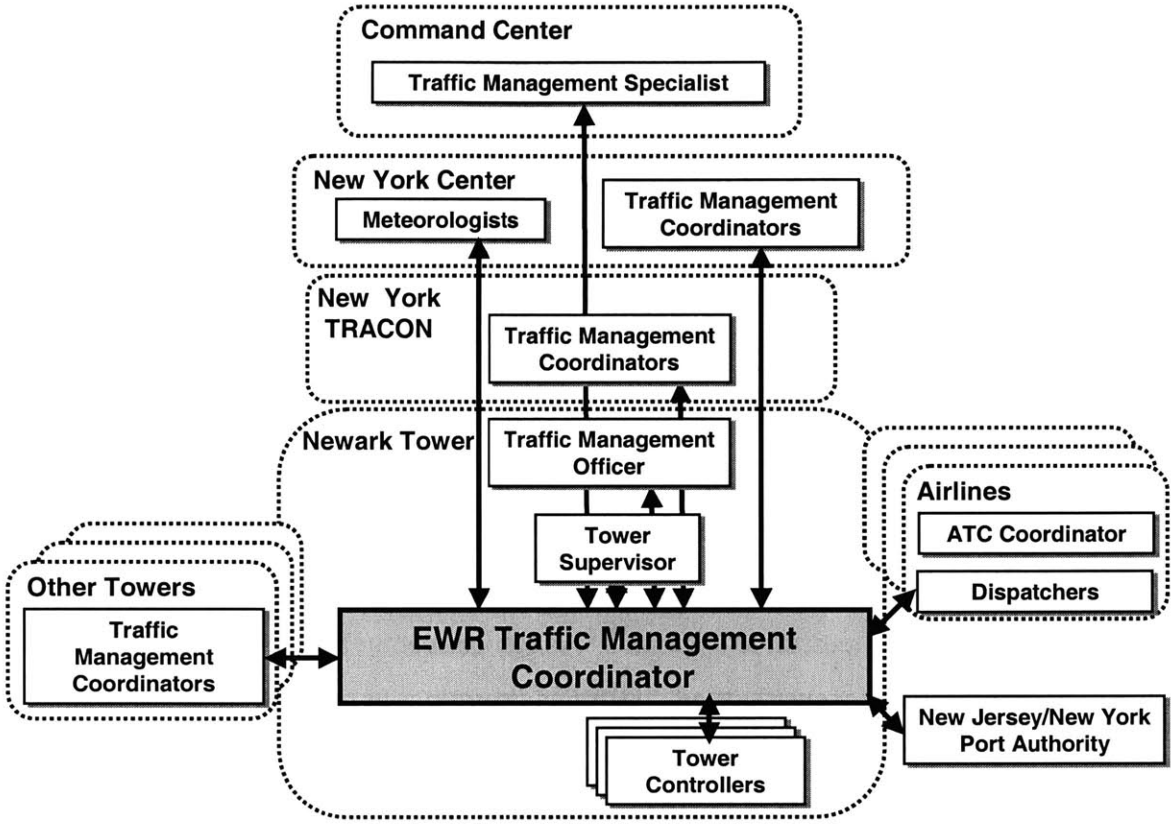

Figure 4.9: Newark Tower TMC communication structure.

Command Center Traffic Management Specialist

The Command Center TMS is responsible for ensuring that the New York facilities are performing at their maximum capacity to minimize negative effect on national air traffic. The Tower TMC communicates with the Command Center about 20 times per day over the telephone, through e-mail, or through the Command Center webpage. Through telephone, the Tower TMC discusses GDP possibilities with the Command Center by estimating arrival and departure rates. The Tower TMC also discusses unusual circumstances that may happen at the airport (e.g., aircraft tire blow-out) that would affect operations at the Tower. Other circumstances in which the Tower

TMC would communicate with the Command Center are during periods of de-icing or when the airport is averaging delays of 40 minutes or more.

New York Center TMCs

The Center TMCs are responsible for maintaining the efficiency of traffic flow throughout the Center airspace while ensuring that the Center controllers are not overloaded with traffic flow from other facilities. The Tower TMC communicates with the Center TMCs through the telephone or through the FDIO (see Appendix A) on average of 3-4 times per hour. Notification of the initiation of GDPs and APREQs are provided to the Tower through the FDIO/GI Message System.

The Center is also contacted in case a departure re-route is needed or during de-icing periods. The Center TMCs may contact the Tower to determine the airport's or a specific aircraft's delay status. The departure sequence from Newark is either communicated to the Center through telephone calls during the APREQ program or through the Departure Spacing Planner (see Appendix A).

New York Center Meteorologists

The Center meteorologists provide a weather forecast to the New York area towers and the TRACON once per day at 7 a.m. through the telephone. Much of the information on the current weather is communicated through the Doppler weather radar displays located in the Tower. An Integrated Terminal Weather System display also aids the Tower in predicting the movement of thunderstorms during the summer months (see Appendix A for more information).

New York TRACON TMCs

The TRACON TMCs are responsible for maintaining the efficiency of traffic flow throughout the TRACON airspace while ensuring that the TRACON controllers are not overloaded with traffic flow from other facilities. The Tower TMC communicates with the TRACON TMCs through the telephone, fax, or e-mail constantly throughout the day. Reasons behind restrictions on fixes and routes are discussed between the Tower and the TRACON so that an alternative may be found if available. The Tower TMC telephones the TRACON when a new runway configuration is put into use. The Tower TMC may also telephone the TRACON to discuss possible alternatives to current routes or procedures to adjust dynamically to the situation. The departure sequence from Newark is either communicated to the TRACON through telephone calls during the APREQ program or through the Departure Spacing Planner (see Appendix A).

Newark Tower Traffic Management Officer

The Tower TMO is the managerial head of the Newark Tower facility. The Tower TMC communicates with the Tower TMO on average of one time per day to discuss the plan of the day with the TMO and update him on the current and predicted Tower situation.

Newark Tower Supervisor

The Tower Supervisor is ultimately responsible for the operational decisions made at Newark Tower. The Tower TMC communicates with the Tower supervisor constantly face-to-face to discuss the Tower's situation and how it can be improved throughout the day.

Newark Tower Controllers

The Tower Controllers tactically interact with the aircraft at Newark Tower. There is constant communication between the Tower Controllers and the Tower TMC. The Controllers receive information from the Tower TMC to maintain current information on the programs that are constantly changing within the NAS that affect Newark operations. The Tower TMC monitors the workload of the Tower Controllers to make adjustments in the programs to reflect this workload and the airport's current status.

Other Towers' TMCs

The Tower TMC at Newark may communicate with Tower TMCs at JFK, La Guardia, and other area airports1-2 times per day over the telephone. This communication is to share weather information or to provide each other with wind information.

Airlines ATC Coordinators and Dispatchers

Airline ATC Coordinators are employees of the airlines that are often retired controllers who aid the airlines in communicating with ATC about traffic management issues. Airline Dispatchers are airline employees that are responsible for the pre-flight planning, delay and dispatch release of a group of flights for a particular airline. The Tower TMC communicates with the airlines from 1-30 times per day depending on the weather and traffic. During busy periods, airlines will constantly call the Tower TMC to get information on a specific aircraft or to discuss the routings given to aircraft. The Towers may contact the airlines (especially the airlines with a hub at Newark—Continental Airlines) to notify the pilots of a situation developing at the airport that may affect their departures. The Tower may contact the airlines to hold certain aircraft, expect holding on the taxiways, or to expect a runway closure.

New Jersey & New York Port Authorities

The Port Authorities are responsible for maintaining the runways and ensuring the airport is operational so as not to inhibit air traffic operations. They also own the gates at Newark Airport. The Tower TMC may contact the port authorities up to 30 times per day through the computer to check on construction updates, runway inspections, and to gain estimates on aircraft holding due to lack of gate availability.

4.3.1.2 Communication and coordination problems

The Newark Tower TMC also provided some communication and coordination problems that were experienced:

Rationale behind restrictions on departure fixes not provided: Tower TMCs cannot proactively search for a solution to the flow problems out of a certain fix if the rationale behind the restriction is not provided.

Command Center is not proactive about helping the Tower: The Tower TMC does not want to know why a certain re-route is not allowed, but how the Command Center can help the Tower remedy the situation.

APREQ procedures are cumbersome: The APREQ program initiation is sent out through the GI Message system to the Towers, but then the Towers must wait for the phone call from the TRACON to get approval to release aircraft.

Excess communication with the TRACON: Often when the TRACON releases a restriction from a fix, the Tower must first telephone the sector controller at the TRACON for approval before releasing any aircraft over that fix.

National Playbook makes communication inefficient: The National Playbook is a coordination tool that proceduralizes several common national re-routes that are used during severe weather to reduce inter-facility coordination. The Command Center is coordinating with every Center independently to handle traffic that they do not normally handle, making the operations complicated.

Command Center's lack of authority: The Command Center has no authority to tell Centers that they have to take a certain route, so extra coordination is needed to implement traffic initiatives.

4.3.1.3 Suggestions for improved communications/coordination

In addition to the problems that they had, the Newark Tower TMC also provided some suggestions for improving the coordination:

Combining Tower and TRACON facilities: By combining the facilities, being acquainted with controllers from the other facility would help operations by providing a personal element to operations. One Tower controller commented, "We could see the (TRACON) controllers over lunch and tell them that they're killing us in the Tower with the decisions that they made earlier."

Adjust the type of people that are recruited by the FAA to be controllers: Currently the FAA recruits independent and strong-willed people to be controllers, but more flexible and accommodating people are needed for collaborative traffic management duties. A Tower controller responded, "The 'Type A" personalities are all fighting against one another to come up with the best overall solution, and that is just not efficient."

Rationale behind restrictions should be provided: By knowing the rationale behind fix restrictions, alternative routings can be suggested by Tower TMCs.

4.3.1.4 Additional observations

During the site visit to Newark Tower, the TMC participated in a teleconference between the facilities in the New England area: Boston facilities, New York facilities, Washington, D.C. facilities, and the Command Center. This teleconference is held once per day. The content of the teleconference observed is presented below.

New England Regional Teleconference

In this teleconference, several points are addressed for each airport:

- Yesterday's problems, programs, and reasons for programs
- Today's airport runway configurations
- Plan of the day and the reasons behind it
- Expected arrival rate
- Expected programs and reasons for the program

Newark Tower reported the runway configuration ("using the 22's & will be circling to 29 occasionally") which was due to "strong winds out of the west." The Tower TMC responded that sometimes a facility will want to know the reason why a specific situation happened the day before and will generally follow up on the situation after the teleconference to avoid the presence of the airlines on the teleconference.

Chapter 5

Results of Site Visits- Air Traffic Control System Command Center

Presented below are the results of the site visit performed at the Air Traffic Control System Command Center (ATCSCC or "Command Center"). Two positions were interviewed as representatives of the Command Center. Included in the results from each position is a detailed communication and coordination structure for each position, the information tools utilized, the problems that the position found in the communication and coordination associated with the position, and any other pertinent observations.

The Command Center is the strategic head of the air traffic management system today. Located in Herndon, Virginia, the Command Center consists of a group of air traffic controllers whose goal is to maximize efficiency across the entire NAS.

The Command Center is divided into East and West areas, and the areas are separated by the Mississippi River. Though the West covers a significantly bigger area than the East, the East is commonly recognized as the more complicated of the two due to the Boston-Washington- New York- Chicago business travel routes. Pictured in Figure 5.1 is a photograph of the Command Center facility, and the schematic in Figure 5.2 shows the East division.

Figure 5.3 is a diagram of the communication structure within the Command Center. The Command Center is headed by a Facility Manager, who makes final decisions regarding the entire facility. A National Operations Supervisor makes decisions regarding both the East and West areas. Severe Weather and Strategic Planning groups specialize in re-routes due to traffic and weather throughout the NAS. Within each area is an East or West Supervisor, who makes decisions regarding their specified

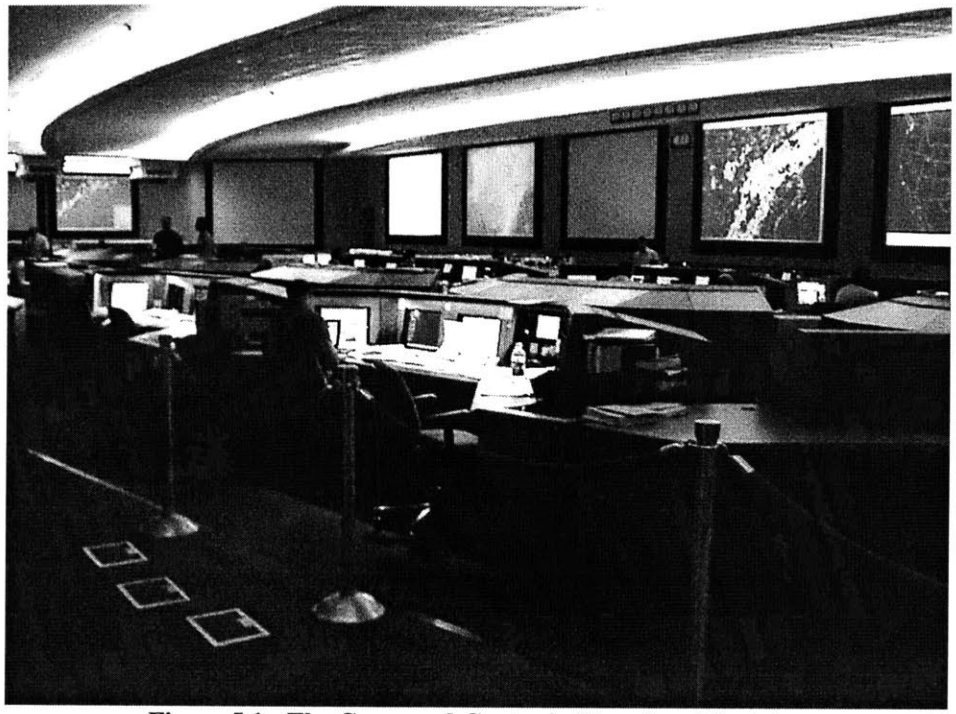

Figure 5.1: The Command Center in Herndon, Virginia.

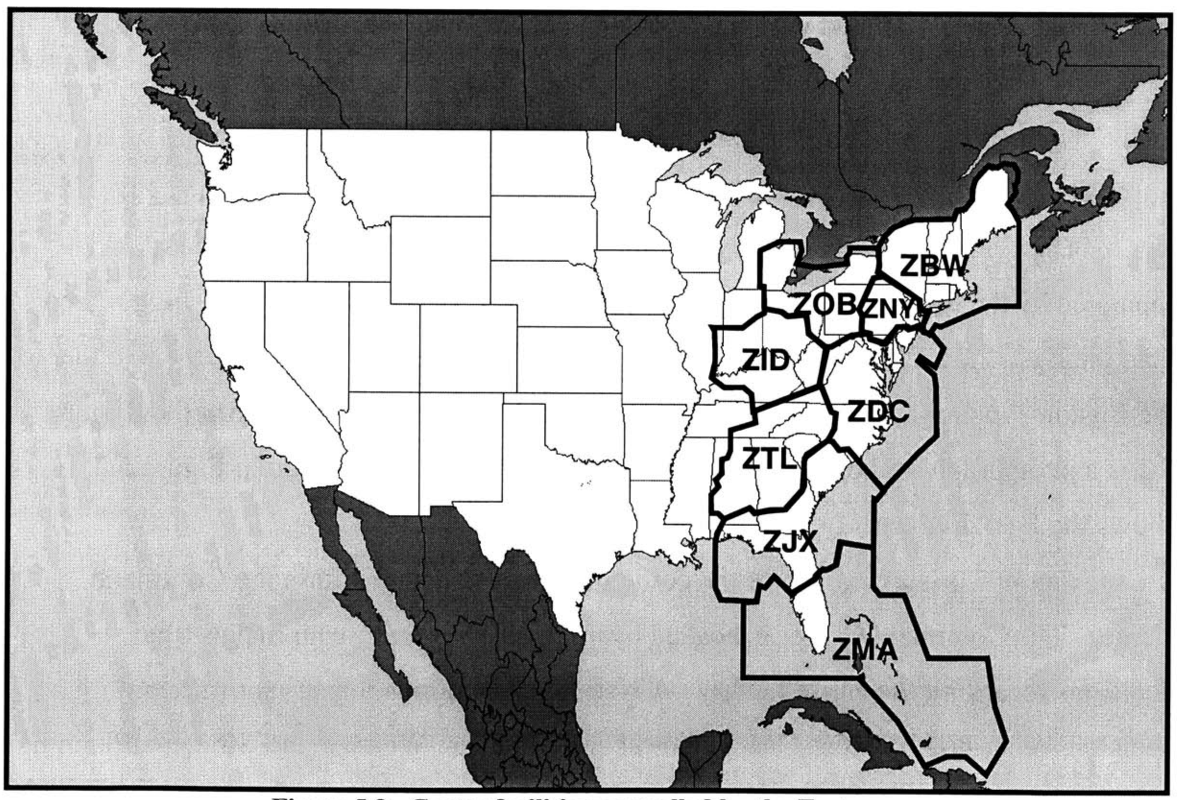

Figure 5.2: Center facilities controlled by the East area of the Command Center (Flight Explorer, 2001).

area. An Air Transportation Association (ATA) representative is present in each area to provide the facility with advocates for the airline sides. Under the East Supervisor are several Traffic Management Specialists who are in charge of an assigned Center facility.

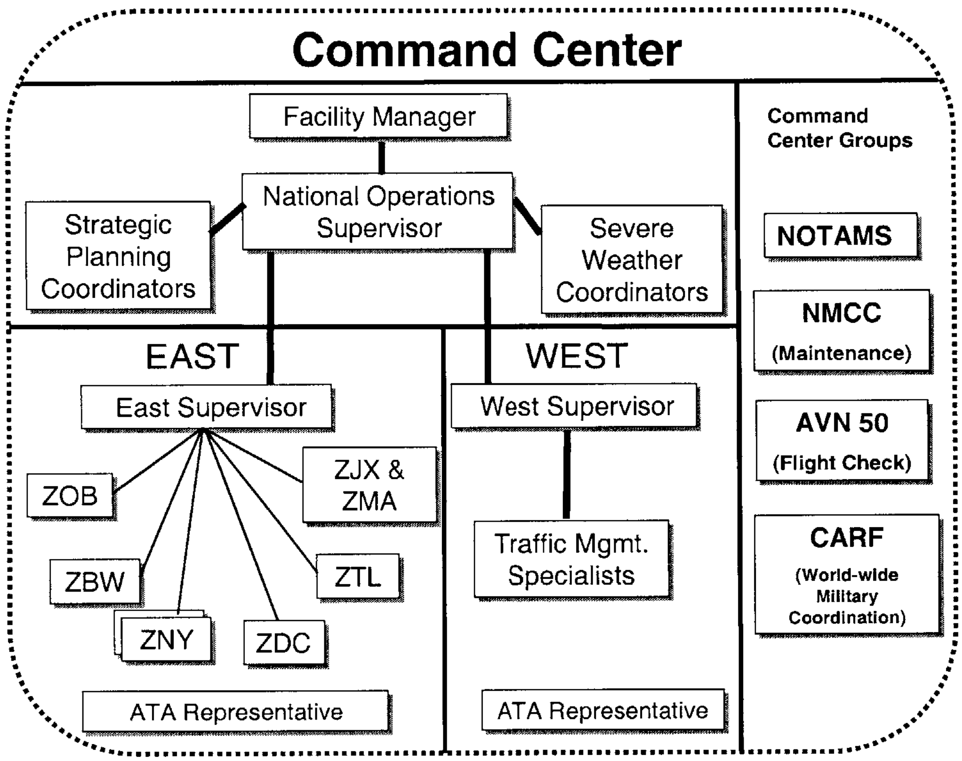

Figure 5.3: Command Center communication structure.

5.1 Traffic Management Specialist

The Traffic Management Specialist has several functional tasks, some of which are:

- Gathering information from air traffic facilities regarding the current status of the facilities
- Gathering information from and providing information to Strategic Planning and Severe Weather groups within the Command Center regarding the current and future plans for the NAS
- Communicating with the airlines and the air traffic control facilities to decide on a solution that enhances both efficiency and safety

- Suggesting the implementation of traffic initiatives such as the Ground Delay Program and determining how delays will be distributed across facilities to ensure equal treatment

5.1.1 Communication and coordination structure

The communication and coordination structure provided in Figure 5.4 was elicited from the TMSs interviewed:

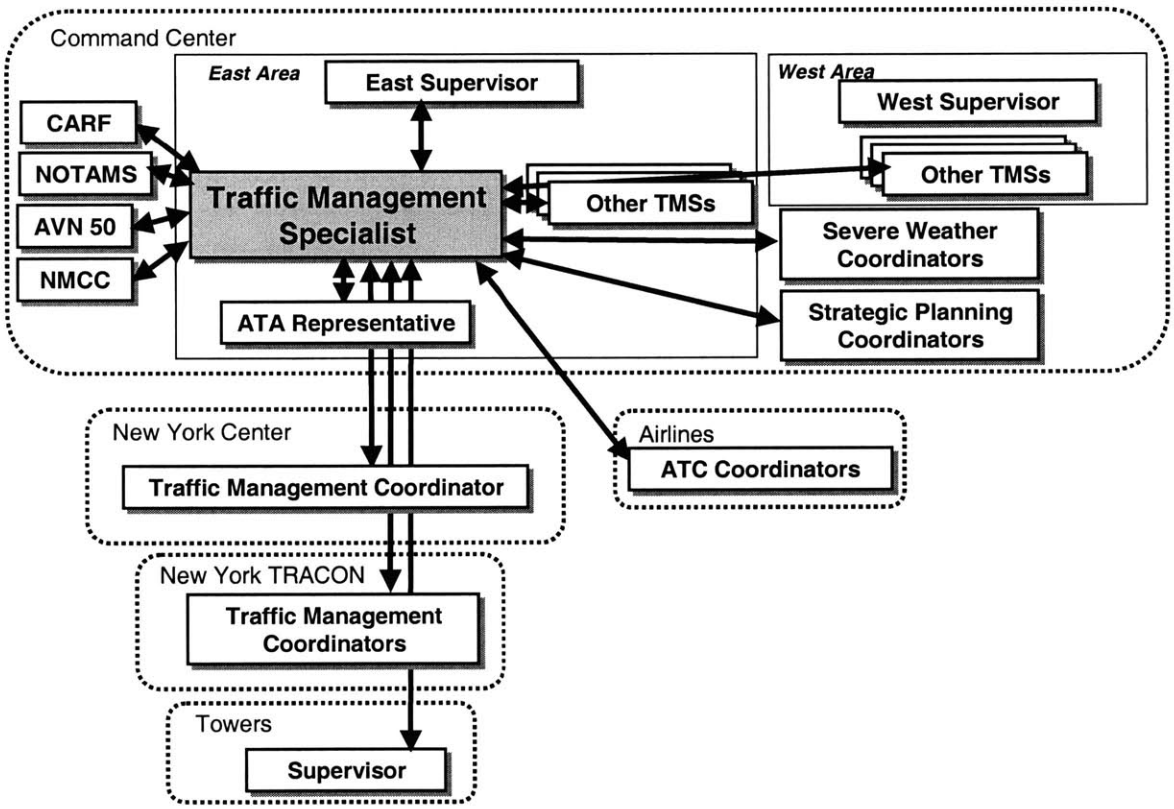

Figure 5.4: Command Center TMS communication structure.

Command Center East Supervisor

The East Supervisor is responsible for the efficiency of the operations in all facilities east of the Mississippi River. The Command Center TMS communicates with the East Supervisor face-to-face every five minutes. Much of this communication is updating the East Supervisor on the current situation in the area that the TMS is working.

On occasion, the TMS might request for the East Supervisor to intervene in a situation in which the Center TMCs are behaving inflexibly towards the TMS's requests.

Other Traffic Management Specialists

TMSs of adjacent facilities are critical information sources for a TMS. The TMS communicates with other TMSs in the facility every five minutes face-to-face. These communications often involve gathering information on expected traffic demand or emergency issues affecting their own airspace.

Air Transportation Association (ATA) Representative

A representative from ATA is located in each area of the Command Center to provide a airline perspective in the Command Center. The TMS communicates with the ATA representative every five minutes face-to-face to resolve questions that the TMS may have about what the airlines would prefer on certain traffic management decisions. The ATA Representative may also contact the TMS to understand the rationale used behind a traffic initiative put into place.

Central Altitude Reservation Function (CARF)

The CARF group is responsible for reserving military airspace. The TMS communicates by phone with the CARF group to coordinate when and where the military has reserved airspace. This communication occurs approximately once per day by telephone.

Notices to Airmen (NOTAMS) Group

The NOTAMS group is responsible for compiling restrictions that will be broadcast to pilots that may affect their flights. The TMS communicates with the NOTAMS group constantly by telephone to update the restrictions affecting the TMC's airspace.

Flight Check (AVN 50) Group

The Flight Check group is responsible for testing newly maintained equipment at the airports within the NAS. The TMC communicates with the AVN 50 Group once per day by telephone to coordinate when is the best time to fix surveillance equipment in the TMC's airspace, and what effect the maintenance will have on operations. The Flight Check Group is responsible for arranging the maintenance of surveillance equipment throughout the NAS, and then testing the equipment after maintenance is completed through a test flight that is arranged with the TMC.

National Maintenance Coordination Center (NMCC)

The NMCC is responsible for scheduling maintenance of equipment throughout the NAS. The TMS communicates by phone with the NMCC once per week. The TMS discusses major maintenance that may be occurring within the assigned airspace and what equipment is out of service, as well as how long until the maintenance is finished.

Severe Weather Coordinators

The Severe Weather Coordinators are responsible for determining when re-routes are needed due to severe weather and what those re-routes will be that will negatively affect traffic the least. The TMS communicates face-to-face with the Severe Weather Coordinators once per hour during clear weather days and constantly during severe weather days. These discussions involve the Severe Weather Coordinators gathering information from the TMSs regarding traffic demand and opinions on how the weather will affect their airspace. The TMS may contact the Severe Weather Coordinator to get updated weather re-routes for aircraft in the airspace.

Command Center Meteorologists

The Command Center meteorologists are responsible for providing the TMSs and the Severe Weather Coordinators with weather forecasts on average of twice per day. Forecasts from the Center and airline meteorologists are compiled into a single forecast by the Command Center meteorologists called the Collaborative Convective Forecast Product, which is available online. The TMS communicates with the meteorologists to determine the predicted behavior of weather entering the assigned airspace. Much of the information on the current weather is communicated through the Doppler weather radar displays located in the TMS workspace and the television displaying the cable network channel, "The Weather Channel". The New York TMS is also provided with an ITWS display (see Appendix A).

Strategic Planning Coordinators

The Strategic Planning Coordinators are responsible for holding the Command Center teleconferences that occur every two hours, and they update restrictions after the teleconferences on the Command Center OIS website (see Appendix A). The TMS communicates face-to-face with the Strategic Planning Coordinators once per hour during light traffic and clear weather days, or constantly during heavy traffic and severe weather days. The Strategic Planning Coordinators often consult the TMS on the best plans for the airspace before the Command Center teleconferences held every two hours.

Airline ATC Coordinators

Airline ATC Coordinators are employees of the airlines that are often retired controllers who aid the airlines in communicating with ATC about traffic management issues. The TMS communicates with the ATC Coordinators from the airlines every 15 minutes by telephone. The ATC Coordinators often ask the reasoning behind routings for aircraft and may try to convince the TMS that another routing would be better for the airline and the Command Center. The TMS uses the Traffic Situation Display and the Flight Schedule Monitor to determine current and predicted traffic demand from the airlines

Center TMCs, TRACON TMCs, and Tower TMCs

The facility TMCs are responsible for maintaining efficiency throughout their airspace while preventing the facility controllers from becoming overloaded with traffic. There is telephone communication between the TMS and the facility TMCs every five minutes. Many of these communications involve the facility TMCs requesting traffic initiatives for their facility or updating the TMS on the current situation at their facility. The TMS may telephone the facilities to inquire about the workload of the tactical controllers or to investigate why a traffic initiative was put into place at a certain time.

The TMSs may also telephone the Towers to find the current runway configuration, but they generally count on the Towers phoning them with updates.

5.1.2 Communication and coordination problems

During the interviews, the TMSs commented on several communications and coordination problems that occur at the Command Center.

Each TMS is required to be proficient in all East or West airspaces: According to the TMSs, they rotate between positions in the East area depending on who the East Supervisor wants to see in each position. The TMS responded that this rotation was very inefficient because some TMSs have no familiarity with the airspace for which they are responsible.

Information saturation at the TMS position: Each TMS is provided with separate tools providing separate functions. The TMS commented that many of the tools are not used (e.g., ITWS) due to task-shedding, and the TMSs mostly rely on the ETMS for the information needed. The requirement to share information with other parties also slows traffic initiative implementations.

Selfish parties ruin CDM initiatives: The TMS commented that for CDM initiatives to be successful, all parties involved must cooperate and compromise. If even one party refuses to "play the game" by refusing to provide information or failing to negotiate, the effort is ruined.

Low job satisfaction among Command Center TMSs: According to the TMS interviewed, there is a high turnover rate of TMSs at the Command Center. The low morale is said to be due to the TMSs feeling as if they have not helped the NAS situation at the end of the day.

TMS position requires different skills than trained at facility level: The TMS commented that the issues that are faced at the Command Center are never "black and white", so TMSs trained as controllers find it hard to understand that TMSs can never make everyone happy. Skills that are taught at the facility level, such as assertiveness and confidence are not necessarily the best preparation for the TMS position where the TMS must "play nice" with the airlines and the other ATC facilities. The TMS reported that negotiating skills are critical to their position.

TMS position is balancing competing goals: The TMS interviewed responded that it is difficult to resolve the competing pressures of management and their previous training. Management encourages the TMS to favor the airlines in traffic management decisions. On the other hand, their entire training has prepared them to favor the ATC facilities, because it is the TMS's opinion that the Command Center should support the ATC facilities.

5.1.3 Suggestions for improved communication and coordination

Along with the problems, the TMSs contributed their suggestions for improving communication and coordination.

TMSs should become more proactive and flexible: During busy periods, it is tempting for TMSs to apply a "quick fix" to the traffic situations encountered through stopping flows. However, the TMSs reported that better solutions can be found with more coordination and work on the part of the TMS.

Allow TMSs to specialize in one airspace: Stop the TMS rotation, so that the people attending to a certain airspace can develop a deeper understanding of the unique issues that face that airspace. By understanding the issues better, proactive traffic management can occur providing better traffic solutions.

5.1.4 Additional observations

During the interview with the Command Center TMS, he described the process that a TMS uses to implement a Ground Delay Program. This process is detailed in the discussion below.

Ground Delay Program (GDP) implementation through the Flight Schedule Monitor (FSM)

According to the TMS, a GDP is generally implemented with it is observed on the FSM that the predicted demand on an airport exceeds the arrival rates set for that particular time. Based on the information about the demand, the TMS then makes a decision on how to implement the GDP and whom it will affect. There are several options to determine whom the GDP will affect:

- All aircraft destined for the over-scheduled airport
- Internal aircraft: All aircraft within the Center in which the affected airport is located
- 1st tier aircraft: All aircraft within Centers one facility away from the affected airport
- 2nd tier aircraft: All aircraft within Centers two facilities away from the affected airport
- No West aircraft: All aircraft departing east of the Mississippi River

Pictured in Figure 5.5 is an example of the tiers for the New York area airports. The decision about who is affected is made by the TMS based on 1) the number of total aircraft affected, and 2) the average delay allocated to each aircraft. The TMS is able to manipulate whom the GDP will affect before implementation through a "trial GDP" function in the FSM. This allows the TMS to see the effect of the GDP and adjust whom it will affect and how long it will be in place before actually implementing the GDP. The TMS then attempts to distribute the delay as evenly as possible without giving extremely high delays to any particular aircraft.

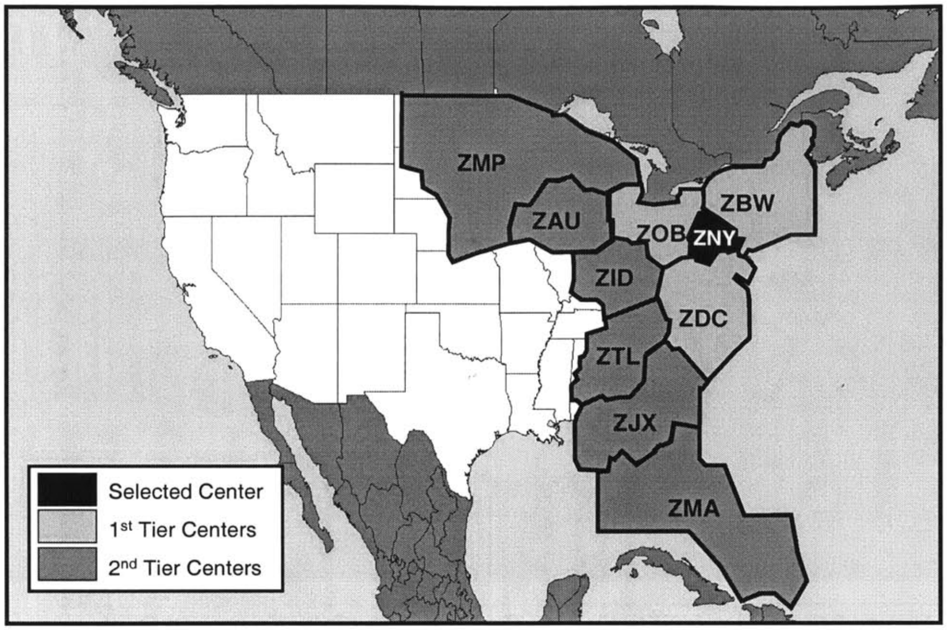

Figure 5.5: First and second tiers that could be affected in the New York area.

Weather is also a consideration during this process. If weather is the reason that the arrival rates are set low and it is only expected to last 1-2 hours, then the TMS may not want to adversely affect flights from the West that may take up to 4 hours to arrive.

5.2 West Supervisor

The West Supervisor in the Command Center oversees all of the West area TMSs, and moderates coordination difficulties between ATC facilities and the airlines that cannot be handled by the TMS. Figure 5.6 identifies the West area for which the West Supervisor is responsible. Due to time limitations during this interview, a communication and coordination structure could not be elicited from the West Supervisor.

5.2.1 Communication and Coordination problems

Several problems pertaining to communication and coordination were provided by the West Supervisor:

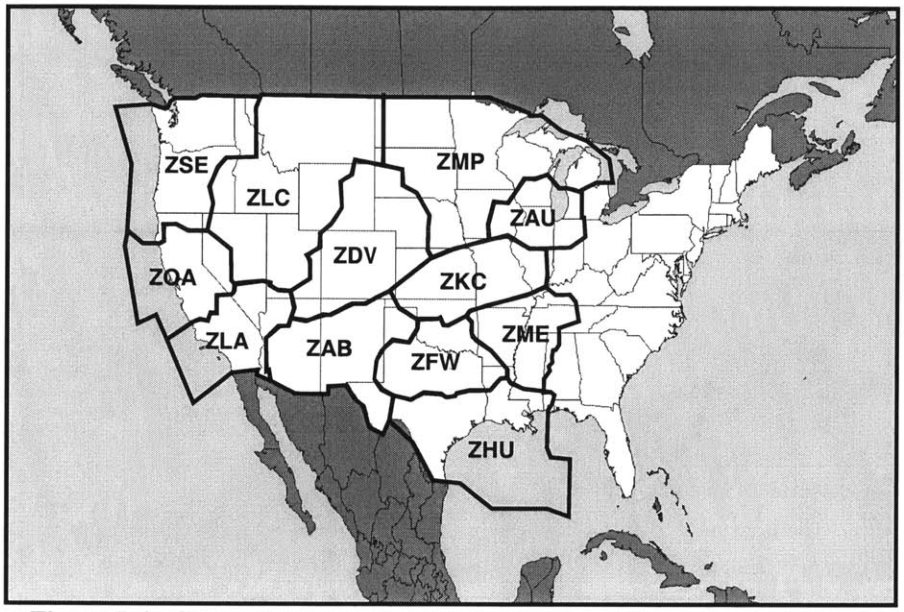

Figure 5.6: Center facilities within the West area of the Command Center.

Reasons for implementing traffic initiatives are not given by ATC facilities: The West Supervisor commented that it is frustrating to make decisions on whether or not to implement a traffic initiative when no reasons are provided from the facilities advocating the initiative.

Communication and coordination is generally more difficult for the East than the West area: The West Supervisor reported that due to the complexity of the airspace and the volume of traffic within the New York, Cleveland, and Indianapolis airspace, communications are often strained. There is not as much of a problem coordinating the West because of the sheer amount of airspace available.

Differing weather information among the ATC facilities and the airlines makes coordinating a common plan difficult: The West Supervisor commented that often the weather forecasts can be ambiguous about the future situation, so the individual parties manipulate the negotiation on the plan to favor their needs. For example, in the teleconference observed on the day of the observation, a fog was affecting much of northern California, delaying departures out of San Francisco. The airlines said that the fog was predicted to last only 2 more hours, while Oakland Center said that the fog would remain for up to 4 hours and a GDP was needed for the airport. The West Supervisor was put into a position to decide whether or not to implement a GDP based on compiling the weather forecasts from the sources listed in the above section.

5.2.2 Suggestions for improving communications and coordination

To address the problems listed above, the West Supervisor suggested one improvement:

Rationale behind the "need" for traffic initiatives should be provided by ATC facilities: Data or reasons supporting the need for the implementation of a traffic initiative should be provided by the Command Center so that the TMS and Supervisor can make better decisions for the NAS.

5.2.3 Additional observations

In addition to the problems and solutions provided, the West Supervisor also shared an opinion about the function of the Command Center in NAS operations.

Function of the Command Center in NAS operations

The Command Center's function in aiding NAS efficiency is to tell ATC facilities their "role" in the overall plan for the nation and the Command Center expects that plan to be met. The TMSs in the Command Center have to "sell" the plan to the facilities to increase the probability that each Center will do its part to ensure the success of the plan. If there is deviation from that plan, then the Command Center steps in and telephones the Center TMU Supervisor to find out why there is deviation. If the TMU Supervisor is uncooperative, then the TMS or West Supervisor then approaches the Center Traffic Management Officer to remedy the problem.

Chapter 6

Inter-facility Information Flow

In Chapters 3-5, results of site visits at seven different facilities were reviewed. From the interview conducted, communication problems surrounding each facility position were revealed. In this chapter, the investigation will extend a step further, and the inter-facility interactions between the various traffic managers will be examined.

To investigate inter-facility coordination, four different interactions will be discussed. Each example represents a different type of coordination between facilities—the interactions can be strategic or time-critical, or they seek to minimize local impact rather than national impact. The common thread among the different interactions that will be discussed is that the success of each interaction requires the coordination between multiple facilities.

Example 1 discusses the process involved in the implementation of a Ground Delay Program traffic initiative. It is critical for the facilities to respond quickly to the needs of other facilities, or, as seen in this example, the overloaded facility will bypass local facilities and request action directly from the Command Center. Also exhibited in this example is the desire for the facilities to respond to the traffic locally without going through the Command Center by coordinating unique solutions to a particular traffic problem. Information exchange and decision making in a long-range planning teleconference will be explained in Example 2. In this example, the importance of shared information will be demonstrated. Finally, Example 3 follows a Boston Center TMC's procedures for determining the oceanic tracks between New York Center and the Oceanic Area Control Center in Gander. This example provides evidence for the importance of redundant communications to increase coordination efficiency.

6.1 Example 1: Ground Delay Program (GDP) Implementation

The Ground Delay Program (GDP) is a traffic initiative implemented by the Command Center to alleviate arrivals at a particular airport for a given period of time. This alleviation is accomplished by sending messages to other Tower controllers to prevent the release of departures destined for the high-demand airport. In this example, the process by which the Command Center TMS determines that a GDP is needed will be discussed as well as the procedure by which the GDP is implemented.

The request for the GDP is based on the needs of the Tower controllers at the overloaded airport. Figure 6.1 provides a schematic of the general progression leading to a request for a GDP. As the arrivals to the overloaded airport increase, the arrival gates become congested and the Tower's tactical controllers become overloaded. The Tower TMC observes this, and once the situation has passed a threshold, the TMC then quickly imposes a local initiative of miles-in-trail (MIT) between arrivals on the TRACON facility. The Tower TMC telephones the TRACON TMC to implement the MIT restriction.

The TRACON TMC then communicates the new MIT restriction to the tactical TRACON controllers. The TRACON controllers then quickly fill the TRACON airspace with holding aircraft, trying to meet the MIT restrictions. Once the holding area is filled, the TRACON TMC passes the MIT restriction back to the Center facility. At this point, alternative traffic relief measures may be discussed with the Center TMC to attempt to handle the arrival flow locally without proceeding to the Command Center level.

After receiving word from the TRACON TMC about the MIT restrictions, the Center TMC communicates the restriction to the Center Area Supervisors, who then communicate this to the tactical controllers. If the demand on that particular airport is particularly high, the Center TMC may be told by the Area Supervisors that the traffic load is too high and the controllers have become overloaded. If the local means of controlling the traffic are not sufficient to curb the intensity of the arrival flows, the Center TMC may telephone the Command Center TMS with a request to implement a GDP on the affected airport. The decision to request a GDP is often dependent on how long the arrival flow is expected to remain too high to handle locally. In addition, if the

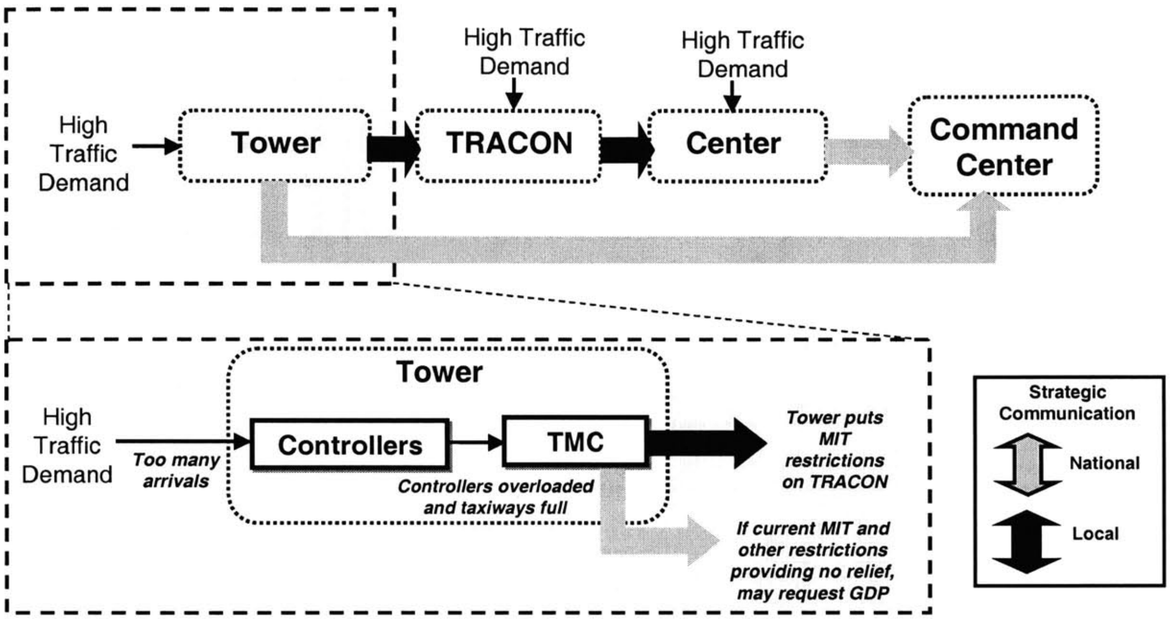

Figure 6.1: Requesting a Ground Delay Program.

Tower TMC does not see changes in the arrival flow due to the MIT restrictions, the Tower may request a GDP directly from the Command Center TMS.

Once the GDP has been requested by one of the facility TMC's, the Command Center TMS must then determine if the initiative is warranted. Figure 6.2 depicts the process. The Command Center TMS rarely, if ever, suggests a GDP without a request having been made by the facilities. Once this request has been made, the TMS determines whether the demand for the airport is sufficient that local measures taken will need to be supplemented by a Command Center initiative. To determine demand, the Command Center TMS consults several sources. The Traffic Situation Display (TSD) is used to determine the prospective arrivals in the air and the airport arrivals that have yet to depart. The airline representatives at the Command Center are also consulted to determine the effect that the GDP would have from an airline perspective. Other Command Center TMS's are approached to gain a more accurate picture of the traffic flows from other airspaces. Using this information, the TMS determines whether an initiative is needed.

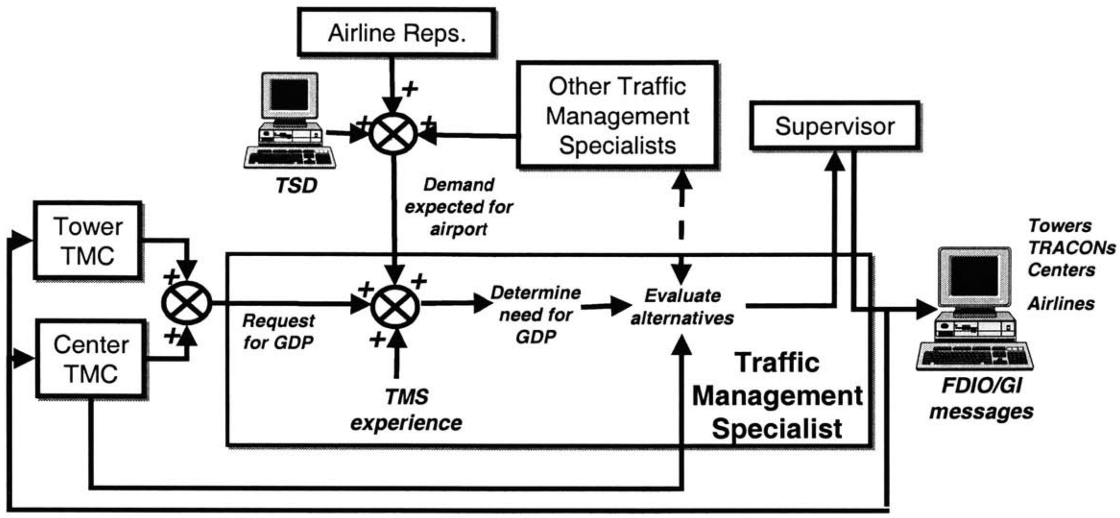

Figure 6.2: Ground Delay Program implementation process.

The Command Center TMS then evaluates alternatives to the GDP to curb arrival flow, such as local measures. This is performed with the aid of the Center TMCs and possibly other Command Center TMSs. Once all of the more favorable alternatives have been exhausted, the TMS may decide to implement a GDP for the airport. This is first cleared through the Command Center East or West Supervisor. If the initiative is cleared, then it is inputted into the FDIO/GI Message System for dissemination among the facilities and the airlines. The Command Center TMS also follows up the initialization with telephone calls to both Center and Tower TMCs to ensure the measure is promptly started and to prevent confusion if the information is not received immediately.

If this decision process is too lengthy, or the outcome does not favor the needs of the Towers, the Tower TMC may choose to stop taking handoffs completely to alleviate controller workload in the name of safety. This situation critically disrupts national flow, thus the Command Center TMS takes requests from the facilities seriously.

6.2 Example 2: Long-range Planning Teleconference

The previous example discussed the dynamic implementation of a traffic initiative. The Long-range Planning Teleconference example investigates the coordination between facilities when an issue that will disrupt operations arises well before the issue will occur.

In this example, planned construction at Providence's T. F. Green Airport (PVD) will disrupt operations for 2-3 days. The PVD Tower closes between midnight and 12:30 a.m. normally, and the Boston Center handles operations into and out of the airport during that period. This teleconference arranged the traffic initiatives that will automatically go into place on the arrival flow into Providence during the period of the construction.

The teleconference was held between Boston Center's TMO, two representatives of Boston Center's tactical controllers, a representative of Providence Tower, New York Center TMO, and the New York TRACON TMU Supervisor. The Command Center TMS would often participate in such teleconferences, but was unavailable for this particular teleconference. The purpose of the teleconference was to discuss traffic management strategies to alleviate air traffic problems created by the runway construction at Providence Airport.

A schematic of the negotiation process between the Providence and Boston traffic managers is displayed in Figure 6.3. At the beginning of the teleconference, Providence faxed a series of requests to the other facilities to ensure that the Tower controllers would not get overloaded. These requests included: 1) Number of entry fixes to be used to the airport during the days in questions, 2) Automatic MIT restrictions to those entry fixes, and 3) Speed of aircraft entering the fixes. Providence requested that 20 MIT with like-typed aircraft be allowed into the entry fixes.

In response, the Boston Center discussed with the Operations representatives whether this request would be too stressful on the Boston Center controllers. The Operations representatives responded that they would agree to the conditions if the traffic demand was not predicted to be too high. The facilities then gathered information on the predicted demand for that day. Some quarrels developed over the predicted demand due to the different information sources used at each facility (canned flight plans, filed flight plans, etc.).

A compromise was made, but the Providence Tower representative was still uneasy about the possibility of the Tower controllers becoming overloaded with arrivals. It was then suggested by Providence that since they do not have a TMU, that Boston Center

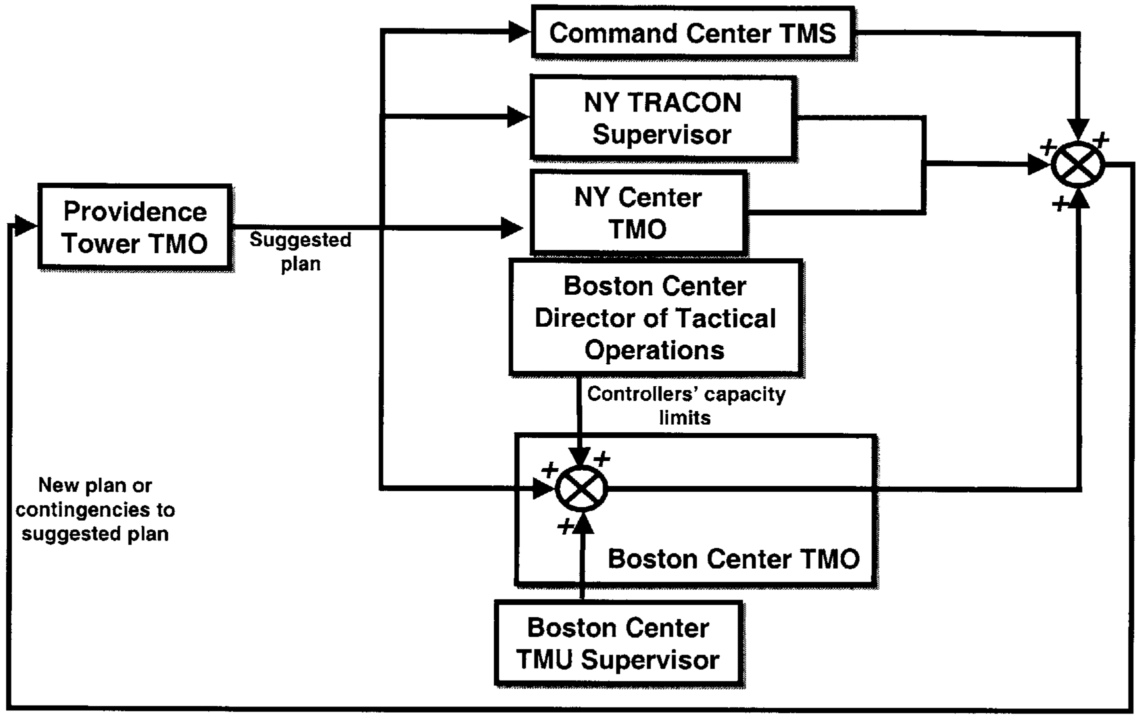

Figure 6.3: Negotiation process during a strategic teleconference.

TMU should monitor the flow to Providence on behalf of the Tower. The Boston TMO agreed to the proposition, but qualified the statement with the request that the Boston Center TMU be notified when to monitor before the Tower becomes saturated. Providence reiterated the fact that they would not know that they were overloaded with traffic until it occurred. Boston Center TMO then offered to provide Providence with hourly demand estimates communicated through fax. The TMO also responded that the Traffic Situation Display is available on the web, but that it could be unreliable. Providence accepted the offer for hourly demand estimates provided by fax.

The operations representatives of Boston Center broached another issue regarding the transfer of authority over landing aircraft to Boston Center after midnight. Due to runway construction, once the aircraft lands, it must then be put into reverse to back up to the taxiway before exiting the runway. Due to the fact that the Boston Center controllers would have no visual feedback to this between midnight and 12:30a, they were uncomfortable handling arrivals. Since the approach charts of Providence airport were outdated on the web, providing the Center controllers no assistance, the Providence representatives agreed to keep the Tower open until 12:30a during the nights of construction.

6.3 Example 3: Boston Center Oceanic Tracks

In this example, the everyday procedure of determining the oceanic routes between New York Center and the Oceanic Area Control Center in Gander is used to demonstrate the importance of redundant means of communication to ensure efficient coordination between facilities. The position that coordinates the tracks is a TMC designate in the Boston Center. The procedure by which the tracks are created and submitted is depicted in Figure 6.4.

Each morning and afternoon, the Boston Center TMC coordinates with the Oceanic Area Control Center (OACC) in Gander to determine the routes for the ocean-bound aircraft. These routes must be compatible with both the winds and with the controller staffing at Gander. The first task of the Boston Center TMC is to consult the Center meteorologist to determine the winds and the jetstream information for that afternoon. Depending on the wind information, the tracks will either lead to the northern or southern oceanic routes.

The Boston Center TMC then telephones Gander facility to determine the staffing that the facility will have that evening. This staffing information allows the TMC to divide the tracks into the appropriate number, without overloading any particular controller at the Gander facility.

Once the tracks have been created based on the wind and staffing information, the Center TMC types them into electronic form. The tracks are then sent for approval by the Boston TMU Supervisor. Once the tracks are approved, the Boston Center TMC sends the tracks through ETMS e-mail, which connects to the OACC, the Centers, the Airlines, and other world-wide ATC facilities.

The Boston Center TMC then telephones the Gander OACC facility TMCs and the New York Center TMCs personally to ensure that those facilities are aware that the tracks have been sent. This is useful so that if the tracks e-mail was unsuccessful, the Boston Center TMC can send it again immediately. The Boston Center Sector Supervisors and the TMCs are also verbally told that the tracks have been submitted.

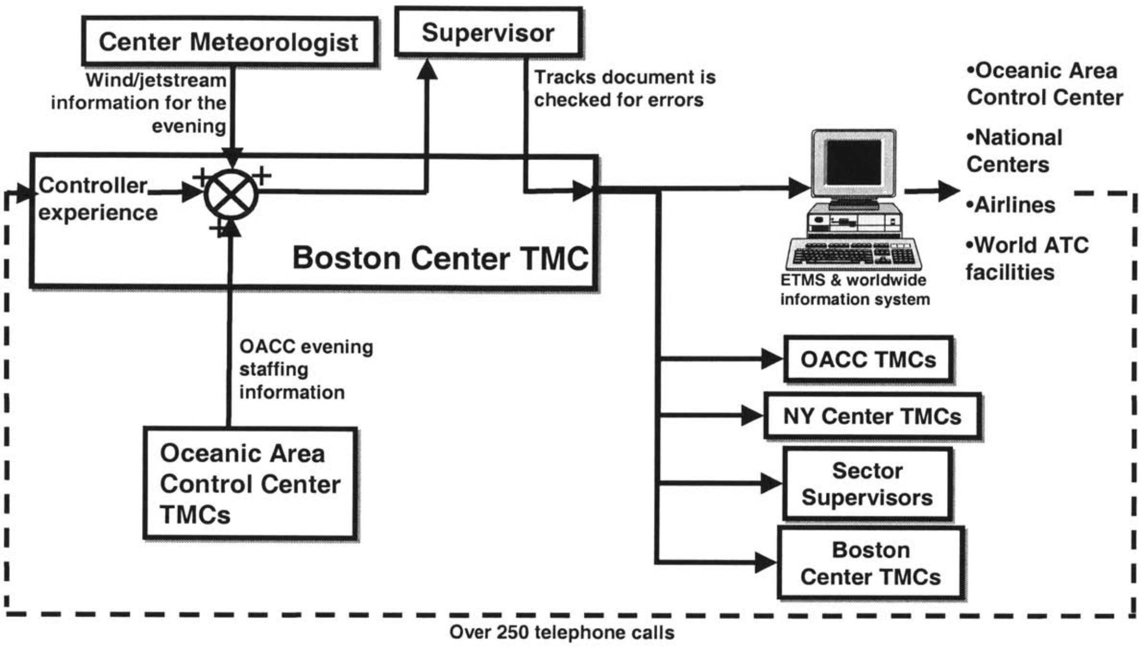

Figure 6.4: Oceanic tracks are created by the Boston Center TMC.

According to the Boston Center TMC, this extra communication is needed to ensure that the e-mail was successful and to make the facilities aware that the tracks have been completed. If this pre-emptive verbal reminder is not performed, the Boston Center TMU may be engulfed with over 250 telephone calls from facilities either who missed the e-mail or failed to receive the e-mail. This extra communication is a method to avoid such time-consuming telephone calls.

Chapter 7

Discussion

In Chapters 3-5, communication structures for Traffic Management Coordinators were identified, and the perceived problems with inter-facility communication were described for each position interviewed. Chapter 6 then extracted specific inter-facility communication examples that demonstrated current communication issues spanning across positions and tasks. In this chapter, general comparisons across the facilities will be made and themes that have emerged throughout the interviews and field observations will be discussed.

7.1 Facility comparisons

During this study, eight different facilities were surveyed to provide different perspectives on the issues of inter-facility communication and coordination. The Boston facilities were surveyed as representative of airspace containing a single major airport, which is common across the U. S. As a comparison, Manchester, a satellite facility of Boston, was investigated as a facility with significantly less traffic than Boston. The New York facilities were examined as a comparison to Boston from the perspective of a facility with higher traffic demand with four major airports within the airspace.

From these comparisons, it was found that facilities that served less traffic were more likely to deviate from the nominal routes to accommodate the traffic flows in circumstances such as weather or heavy traffic flows. The more traffic that the facility served, the more the TMCs were engulfed with nominal tasks of passing restrictions, allowing for few pro-active traffic management attempts. As expected, communication maladies that were present across facilities intensified as the facility experienced heavier traffic loads.

The Command Center was also investigated to gain a national perspective on the communications issues, as opposed to a local perspective gained from the other ATC facilities. When comparing the Command Center TMS's communication structure to any of the local TMCs' structures, it is apparent that the Command Center TMS spends significantly more time communicating than any of his or her TMC counterparts. Because the Command Center TMSs received the same training as the local facility TMCs, many of the views on the problems and solutions regarding communications were similar, if not the same. The finding that most of the facilities agreed on the communications problems was valuable when identifying the emergent themes in the results pertaining to inter-facility communications and coordination.

7.2 Emergent themes

When compiling the results from the site visits, several themes emerged from the identification of communications issues that TMCs found important or particularly problematic. These themes addressed the problems found in inter-facility communication and coordination: ambiguous ATC organizational structure, information flow issues, awkward coordination, organizational culture issues and goal resolution, and the role of personal negotiations in ATC. These themes are expanded and supported in the sections following.

7.2.1 Ambiguous organizational structure

In Chapter 1, the factors that supported effective communication were discussed, and organizational structure was found by French, et al. (1985) to be one of the most influential aspects of communication. The ATC system was also found to exhibit aspects of both a centralized and decentralized organizational structure. At the national level, the Command Center leads many of the teleconferences pertaining to national flow issues, and the approval of the Command Center is required before implementing a national traffic flow initiative (i.e., centralized control). Chapter 6 provided an example of the implementation of a national traffic flow initiative, the Ground Delay Program. In comparison, the local network of communication and coordination exhibits more of a decentralized structure. Even though the Command Center led many of the national flow initiatives, the local facilities retained ultimate control and could stop traffic flow into their facility at any time. In addition, many of the local traffic initiatives were arranged through joint efforts made by the Center, the TRACON, and the Tower facilities.

The results supported the conclusion of an ambiguous organizational structure with 10% of the problems found to pertain to the issue. The most obvious victim of the ambiguity was the Command Center TMS. From the literature, the possible results of inadequate organizational structure are: 1) poor motivation and low morale, 2) poor decision making, 3) conflict and lack of coordination, and 4) failure to respond creatively to challenging circumstances (Child, 1977). According to the Command Center TMS interviewed, there is low job satisfaction among Command Center TMSs. The reason stated for this dissatisfaction was that there are competing goals between how the TMSs were trained to favor safety, and managerial pressure to favor efficiency in air traffic control.

Further supporting the conclusion of ambiguity in organizational structure was evidence provided by the local ATC facilities. Both New York and Boston Centers expressed confusion about the role of the Command Center and the role of the local facilities, particularly the Centers. Results from the New York Center TMC contained the response that the ATC structure is ambiguous and that the Command Center is taking authority from the Centers without replacing that authority with its own. Boston Center complained of a "lack of authority" when communicating with the Command Center. The Newark Tower TMC also observed that there was a lack of Command Center authority during traffic management negotiations.

Local facilities have attempted to cope with this ambiguity of authority by minimizing the national initiatives that are used to solve the local facilities' problems. Facilities will first attempt to implement Miles-in-Trail, Departure Spacing Planner (in Boston), or holding patterns in sectors to respond to temporarily high traffic demand. National traffic initiatives such as Ground Stops and Ground Delay Programs are used as a last resort only in consistently high demand situations. In the GDP program implementation example in Chapter 6, evidence is provided for favoring of the local initiatives over the national initiatives.

7.2.2 Information flow issues

A second theme that extends throughout the results from the site visits is the issue of information flow. Over 25% of the problems stated involved tribulations pertaining to lack of needed information, poor quality of information, conflicting information or information saturation.

As was discussed in Chapter 1, the information flow is critical to an organization, especially an organization like air traffic control, which makes many decisions in the presence of a degree of uncertainty. Efforts have been made to provide an exhaustive set of information to the Command Center TMS's to improve decision-making. Unfortunately, as found in the site visit to the Command Center, so many separate information tools are provided to the TMS that it is difficult to integrate the information into a single mental picture of the situation affecting his or her assigned airspace.

To reduce the communication task load of the TMS, both the number of the communications required is held to a minimum through using a serial (i.e., grapevine-type) communication network and the content is also reduced to the essential pieces. The Command Center telephones the Centers with a new or revised restriction, and the Centers input this information into both the FDIO/GI Message System and the Center Intranet websites. Some Centers telephone the TRACONs and Towers with this new information. The TRACONs and Towers then pass the information to the tactical controllers through the IDS-4 system or through word-of-mouth. According to the TMCs, information is lost during this process or it is not passed on in a timely fashion. The Tower TMCs in Boston and Manchester particularly had a problem with lost or late restriction information.

Even if the information arrives in a complete form, the message is in the form of a restriction (i.e., "BOSOX fix closed to departures until 20:00") without a rationale behind the restriction. This is frustrating for a TMC who may find another route for the aircraft if the reason was provided behind the initial restriction. Newark Tower TMC stated the need for a rationale behind restrictions during the interview. The need for a rationale behind a request also holds for the Command Center TMSs. The West Supervisor responded that the Command Center could make more well-informed decisions if the local facilities would provide reasons behind the need for a national traffic initiative to be implemented.

Another information issue that emerged is the difficulty in making decisions based on different sets of information. During many of the strategic decision-making sessions, such as the teleconference example in Chapter 6, information was needed on predicted traffic demand, weather, and controller staffing information to make a decision. As seen in the teleconference example, many times the parties were using different sets of information, leading each party to favor a different decision. TMCs often need to first coordinate what information is to be used during decision-making before actually attempting to coordinate a resolution to avoid conflict between TMCs.

This solution can be curtailed, however, when information is only available to one party. This is the case when a TMC attempts to convince the Command Center TMS to implement a traffic initiative based on the facility controllers' workload limitations. In the New York Center, the TMC is able to integrate information on predicted demand from the ETMS tool with the information on the controllers' radar scopes to develop a complete picture of the situation. The Command Center TMS only has access to the ETMS data, so often his or her decisions are made based on lack of important information, in this case, the controllers' current situation. The Boston Center TMO expressed a need for better quality and more available information on traffic demand, weather, controller traffic load limits, and controller staffing. The Boston Center TMC requested more information on TRACON controller traffic load limitations. The Boston TRACON TMC would be interested in sharing the metering list from the Boston Center. New York TRACON expressed an interest in receiving more information about the arrival and departure flows at Newark Airport. Many of these issues can be solved through sharing the information among facilities.

The answer does not appear to be to continue adding information tools to the TMC workstation. As the Command Center TMS has become saturated, so will the facility TMCs. The main problem in this area is the workload associated with the TMC task of inputting new information into several different tools each time there is an update. Let us consider the process of a TRACON TMC who receives a page of restrictions from the New York Center twice per day. This TMC must type in the entire page into a TMC restriction log on the computer, copy the page of restrictions onto the TMU white board, and then telephone the major towers with the information that the restrictions have been sent. While this does not appear to be a time-consuming task, the process of typing a page of restrictions into the computer may take 30 minutes for a TMC who has had no formal typing training. The problem of time-consuming information input was also recognized by the Boston TRACON TMO and Boston TRACON TMC.

7.2.3 Awkward coordination

A third theme that emerged from the results of the site visits was that many of the communications are awkward and unorganized. Approximately 25% of the problems in inter-facility communications related to the problem of awkward coordination between facilities. Two main issues are that re-routing aircraft or traffic flows is not performed dynamically enough to be effective and that lack of an organized structure of multi-party teleconferences wastes time.

Deviating from the normal traffic routes is an undesirable situation that requires a significant amount of inter-facility communication to coordinate, especially if the deviation is large. However, due to circumstances such as weather, emergencies, and traffic demand, deviation from the normal procedures is often required to keep the ATC system functional. Re-routing individual aircraft or flows of aircraft is a situation in which a route is temporarily moved to a new place to avoid a situation such as weather or in which the aircraft are funneled into an already existing airway. In either circumstance, the ability to re-route requires the understanding and approval of every facility affected. Refer to the Boston Center TMC or the Manchester Operations Supervisor results (Sections 3.1.2 and 3.4.1) for examples of the troubles related to re-routing. Because re-routing can be time-consuming, it is often avoided if possible. On the other hand, often-used re-routes are common among facilities with predictable weather or traffic patterns.

Many of the TMCs interviewed expressed an interest in automating these commonly used re-routes as a way of reducing the cumbersome inter-facility communications.

The other awkward coordination problem involves the multiple teleconferences and hotlines that are a regular part of many TMCs' tasks. While the teleconferences provide a method of regularly sharing information, complaints surfaced in the results of the site visits about the redundancy of the teleconferences and the lack of procedures governing them. According to the New York Center TMC, multiple lines of teleconferences can be open at one time discussing the same topic. The hotlines are not governed through procedures, so communication is inefficient and information is lost.

7.2.4 Organizational culture issues

Another theme that emerged from the results is the influence of organizational culture on the TMC position. Mismatches between ATC system needs and the training that was received by the air traffic controller must be resolved by the TMCs. All air traffic controllers receive the same basic training, and then a portion of those controllers proceed to the TMC position once enough experience has been gained.

The air traffic controller is trained from the start of their career to value safety over efficiency in every situation. As a TMC with no direct contact with the aircraft, there is managerial pressure to maximize efficiency, especially at the Command Center level of the ATC system. This has placed many TMCs in a quandary about where to draw the line. This problem was stated both by the Command Center TMS and the New York Center TMC.

Another artifact of the initial ATC training and culture is the tendency for the TMCs to view their facility as an "area of protection". If a national initiative is requested but not granted, the local facilities are more likely to stop the traffic flows completely than collaboratively seek another solution. In the teleconference example in Chapter 6, the Providence controllers were cautious about the arrival flows allowed into the airport during the period of construction due to the possibility of tactical controller overload. Even after the Boston Center TMU offered its services to aid in predicting the traffic demand at Providence during that period, Providence still reserved the right to stop arrivals should the load exceed controller limitations. In more extreme cases, the controllers may underestimate their traffic load limitations to ensure that the limit is not exceeded by another facility.

An additional mismatch is created by the different personality traits required to be a successful tactical air traffic controller versus the traits required to be a successful TMC. According to a Newark Tower TMC, the training of a tactical controller forces the person to be aggressive and confident, so the career naturally attracts that type of person. As a TMC, the personality trait requirements are quite different. To be a successful TMC, the New York TRACON TMC responded that a person must be flexible, be able to relate well to other people, and readily assess the needs of the other person. The two positions require traits that are not necessarily compatible. This mismatch can lead to conflict more often than is necessary.

7.2.5 Personal negotiations

To battle the organizational culture issues that impede communications, TMCs become acquainted with each other through various means so that a level of trust between people, not positions, is developed. With this trust, the TMCs are able to function at the limits of the facility's capacity without fear of the tactical controllers becoming overloaded.

In up-down facilities, such as Boston, the Tower and TRACON controllers may see each other during breaks or lunch and become acquainted informally. The Manchester Operations Supervisor suggested that combining with the Boston TRACON would be an effective means of improving coordination. New York TRACON TMC responded that more efficient communications would be achieved if the New York TRACON was combined with the New York Center.

In other cases, the facility TMO may schedule familiarization visits at adjacent facilities so that the TMCs can become familiar with not only the procedures of the facility, but also with the people who work there. According to the Boston TRACON TMO, yearly visits are scheduled for the controllers and TMCs at the TRACON to visit Boston Center. Both the Boston TRACON TMO and the Boston Center TMC recommended that the familiarization visits should be increased to improve inter-facility communication and coordination.

Airlines have realized the power of personal acquaintances in traffic management negotiations. ATC Coordinators are employed by airlines to better smooth coordination between the airlines and the TMCs. Dispatchers are often sent to the Command Center to become familiar with the people and procedures used at the Command Center.

Chapter 8

Conclusions

This study explored the hypothesis that improving strategic communication within the ATC system could increase NAS efficiency. It examined the strategic communication systems and networks used by several Traffic Management Coordinators from eight ATC facilities. From the results of these site visits, several themes emerged regarding the current state of the communication and coordination system in the U. S. Air Traffic Control System. These themes and possible responses are summarized below.

Ambiguous organizational structure: Traffic management at the national level exhibits aspects of a centralized structure, led by the Command Center. However the Command Center lacks command authority to enforce decisions that have been made. Center, TRACON, and Tower facilities work jointly towards local traffic management solutions, showing evidence of a more decentralized structure at the local level. This ambiguity has created difficulties in communication between the local facilities and the Command Center.

It is important to clarify the organizational structure within the ATC system by increasing the effectiveness of the communications that occur within the air traffic control community. Further centralization of authority to the Command Center would relinquish flexibility at the local level. Without this flexibility, safety concerns may be raised if local facilities are compelled to perform actions that they do not support. Therefore, while it is important to have centralized and decentralized aspects to the ATC system to support goals of safety and efficiency, the problems that this ambiguity of structure causes may be reduced by successful communications between the Command Center and the local facilities.

Information flow issues: Even with advances in information technology in ATC, the information on which traffic management decisions are based often continues to be either unavailable or of poor quality. Smaller facilities may lack basic traffic demand information, causing these facilities to rely too heavily on larger facilities' resources. Those information tools that have been implemented have not always been integrated with existing TMC tools, causing information saturation issues. TMC time is wasted by constantly inputting new or revised information into multiple tools.

To increase the efficiency of information flow in the ATC system, specific suggestions were extracted directly from the focused interviews conducted with the TMCs:

- Provide improved information to TMCs on:
    - Predicted traffic demand
    - Weather
    - Controllers' traffic load limitations
    - Controller staffing information
    - Rationale behind issued restrictions from Command Center and upstream facilities
    - Rationale behind the need for a traffic initiative from the local ATC facilities to the Command Center
- Integrate current information systems to reduce redundancy in data inputting and to reduce information saturation
- Provide similar traffic management information systems to all facilities so that decisions can be made using the same set of information
- Proceduralize the communication of new or revised restrictions, and support the procedures with electronic information systems allowing all facilities to receive the restrictions at the same time.

Awkward coordination: TMCs responded that inter-facility communication was awkward, particularly while performing dynamic aircraft re-routing initiatives. TMCs spend a great deal of time inefficiently communicating and coordinating re-routes between facilities, therefore inefficient routes may be assigned to aircraft to avoid such inter-facility coordination. Cumbersome inter-facility communication also appears in traffic management teleconferences, due partly to a lack of organization. This disorganization causes redundant information to be passed across multiple channels.

The following suggestions were made by the TMCs to improve coordination between facilities:

- Proceduralize commonly used re-routes to reduce cumbersome inter-facility communications
- Re-structure teleconferences and hotlines (e.g., separate hotline into "Arrivals only" and "Departures only" connections)

Organizational culture issues: A basic conflict exists in air traffic management between safety and efficiency that makes it difficult for the TMCs to prioritize goals. Management pressure encourages the TMCs to favor efficiency, while the TMCs basic training as an air traffic controller innately favors safety. The air traffic controller training also influences how facilities are protected. If a facility is becoming overloaded with traffic from other facilities, TMCs are more likely to stop traffic flows completely rather than coordinating with other facilities to find a traffic management solution before the facility is overloaded.

The common training among air traffic controllers has a significant impact on the communications even as the controller progresses to the position of a TMC. The differences between the goals of the Command Center TMS and the local facility TMC should be recognized when considering implications for training. The position of a Command Center TMS should be recognized within the air traffic control community as an important position in the ATC system, because they play an increasingly influential role in the NAS operations. Training in recognition of these individuals should be improved, allowing the Command Center TMS to specialize in an assigned airspace.

Similarly, the Command Center TMSs need to understand and respect the contributions of the local facilities.

Personal negotiations: As a behavior to cope with the organizational culture issues, the TMCs are more likely to trust acquaintances or friends at other facilities to provide the expected traffic loads. It was found that TMCs are more likely to work towards a solution for both facilities if either the TMC at the adjacent facility is known personally or if the TMC has become familiar with the issues that the adjacent facility faces. Familiarization visits organized between facilities aids in this process.

The benefits provided by personal negotiations should be utilized in the ATC system. Suggestions on how to fully explore the possibilities were provided by the TMCs:

- Increase familiarization visits between facilities to improve knowledge of other facility and build relationships between TMCs.
- Encourage TMCs to periodically rotate working at different facilities to experience traffic management from new perspectives.
- Encourage informal meetings between TMCs.

This study has revealed that communications are critical to the performance of the current ATC system. It was found that opportunities exist for increased communications and collaboration in ATC, and these issues should be considered a high priority. Technical, organizational, and social improvements can work synergistically to improve the efficiency of the NAS.

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Appendix A

Air traffic control strategic information tools

As discussed in section 1.2.3, the information flow is a critical aspect of maintaining effective communication. In air traffic management, much of the information used to make critical decisions is communicated from party to party through strategic information tools such as the Enhanced Traffic Management System and the Command Center's Operational Information System website. Below is a short description of the some of the most representative strategic information tools.

A.1 Enhanced Traffic Management System (ETMS)

The ETMS is a networked computer system that provides system-wide ATC information to aid operational and strategic decision-making for the Traffic Management Coordinators. Included in this system are several tools that provide specific functions:

- **Traffic Situation Display (TSD):** A photograph of the TSD with a weather overlay and the monitor/alert function enabled is depicted in Figure A.1 below. The TSD uses radar surveillance data to provide the TMC with a dynamic plan view display of selected flows of aircraft in a chosen airspace. The TSD also provides the ability to zoom and overlay weather, geographic structure, and ATC airspace structure.

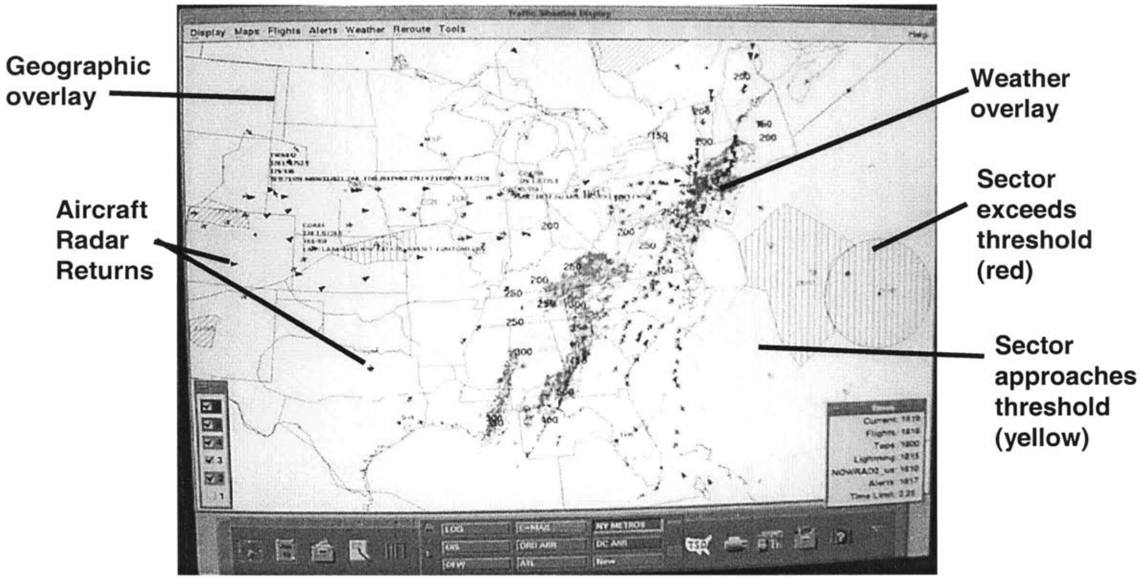

Figure A.1: Traffic Situation Display with overlays and Monitor/Alert function.

- **Monitor/Alert:** In Figure A.2 is an example of the Monitor/Alert function provided by the ETMS. The monitor function samples over 700 sectors, airports, and key fixes across the U.S. and Canada. Using flight plan information, the function is also able to predict activity in 15-minute intervals for 12 hours into the future. The alert function allows the TMC to set a traffic threshold condition for the monitored areas so that the display will alert the TMC when the threshold is exceeded. In the example below, the sector exceeding the threshold is outlined in red with red crosshatching, and the sectors approaching the threshold are outlined in yellow.

- **Flight Schedule Monitor (FSM):** The FSM allows the TMC to determine delay information for any airport using the current flight plans entered into the ATC system. Graphics displaying current and future arrivals are available, and the TMC has the ability to test the effect of a possible traffic flow initiative using the FSM. Figure A.3 is a photograph of the current arrivals for Newark International Airport. A Ground Delay Program is in effect, as can be seen by the brown

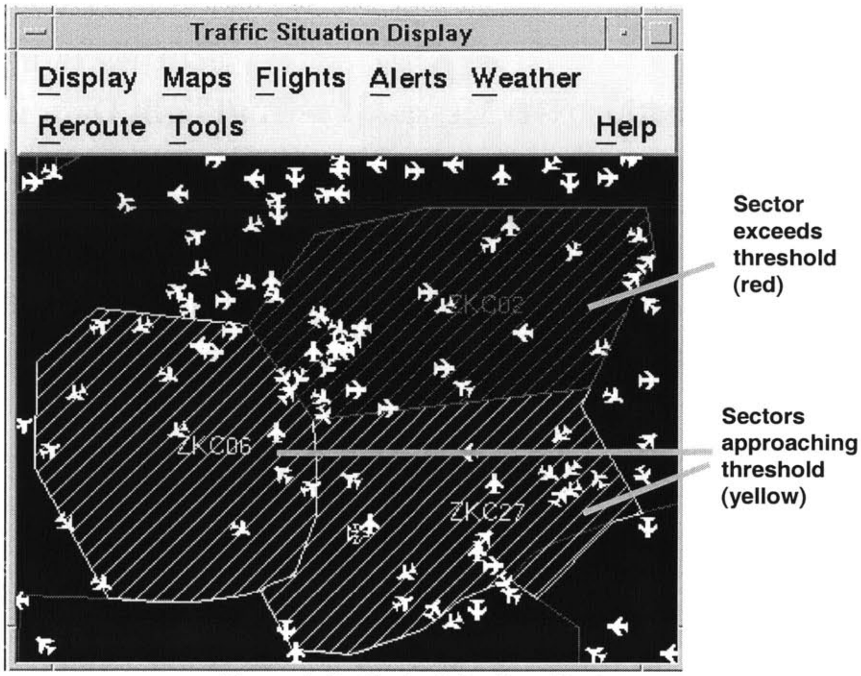

Figure A.2: Sector Monitor Alert.

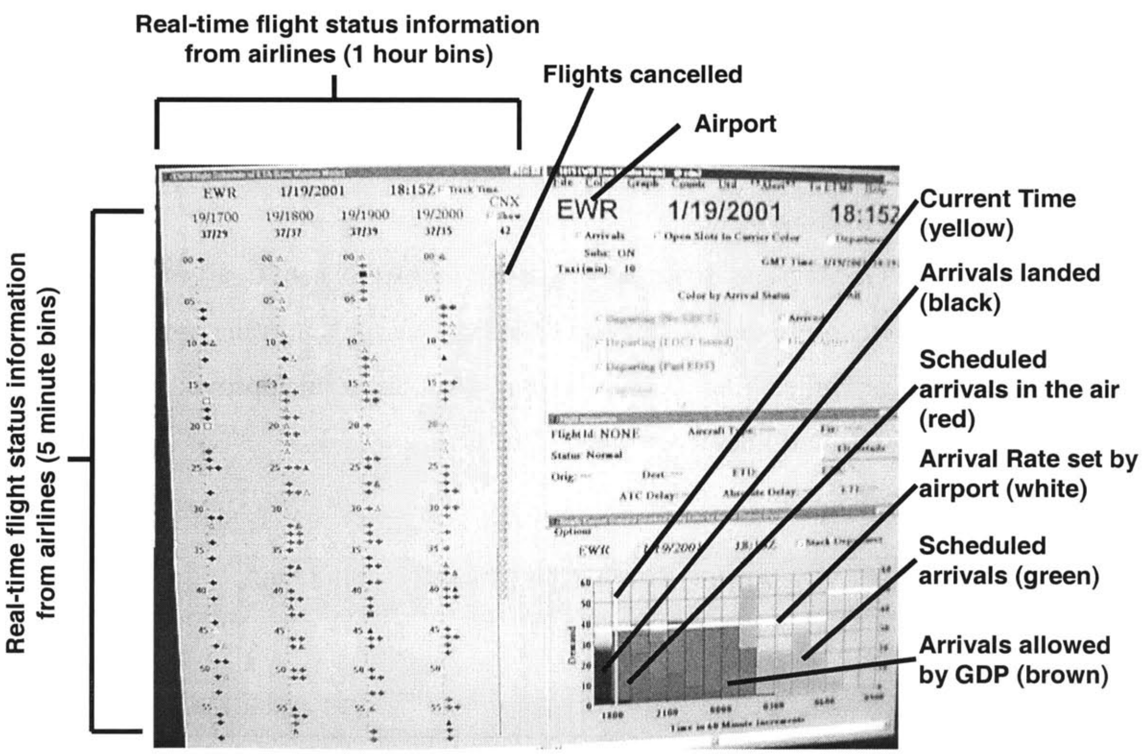

Figure A.3: Flight Schedule Monitor representing Newark Airport affected by a GDP.

columns in the graphic. So for the time of the GDP, no arrivals exceed the set arrival rate.

A.2 General Information (GI) Message System/Flight Data Information Operation (FDIO)

The GI Message System/FDIO is the major route of communication between the Centers, TRACONs, and Towers. Traffic initiatives such as Ground Delay Programs and Ground Stops are passed through this system to ensure that a record is kept regarding when the beginning and end of an initiative was passed to a facility. The Towers and TRACONs receive the GI messages through a flight strip printer at the TMC station of the facility.

GI Message contains information including:

- Airport affected
- Traffic program (Ground stop, Estimated Departure Clearance Time for a particular aircraft, Departure Spacing Program, or Metering program (Boston only))
- Expected length of the program
- Sector to dial in case of questions
- Date and time message sent

An example of a GI Message from the New York TRACON sent to all of the New York Towers is depicted in Figure A.4 below. The GI message states that all aircraft departures destined for Dulles International Airport (IAD) must be approved by the TRACON until 17:30 Zulu (Greenwich Mean Time).

GI W2 ATTN TOWERS- TMU/151551			APREQ TRAFFIC DEST ----IAD----TIL 1730Z.			

Figure A.4: General Information Message indicating the initialization of an Approval/Request procedure for departures to Dulles International Airport.

A.3 Information Display System-4 (IDS-4)

The IDS-4 is a tool that is present at all tactical controller workstations as well as in the Traffic Management Units. This tool allows the TMCs or Supervisors to input facility-specific information that may be useful to the TMCs or the tactical controllers in addition to other general information. Current and forecasted weather, approach plates, separation information, aircraft identification pictures, and facility telephone numbers are all available on the IDS-4. Over 10,000 pages in the tool are available for input, of which approximately 8,500 pages are filled. Only about 10 pages are used consistently, according to controllers.

A.4 Command Center Operation Information System (OIS) Website

The Command Center's OIS website offers the TMCs current information about traffic initiatives that have been put into place, delay information, airport closures, history of arrival rates, current arrival rates, and runway closures for each airport in the NAS. The traffic initiatives are updated once every two hours (during the Command Center teleconferences) by the Strategic Planning Group at the Command Center. Tower TMCs update the airport information as it changes. A picture of the OIS website is shown in Figure A.5.

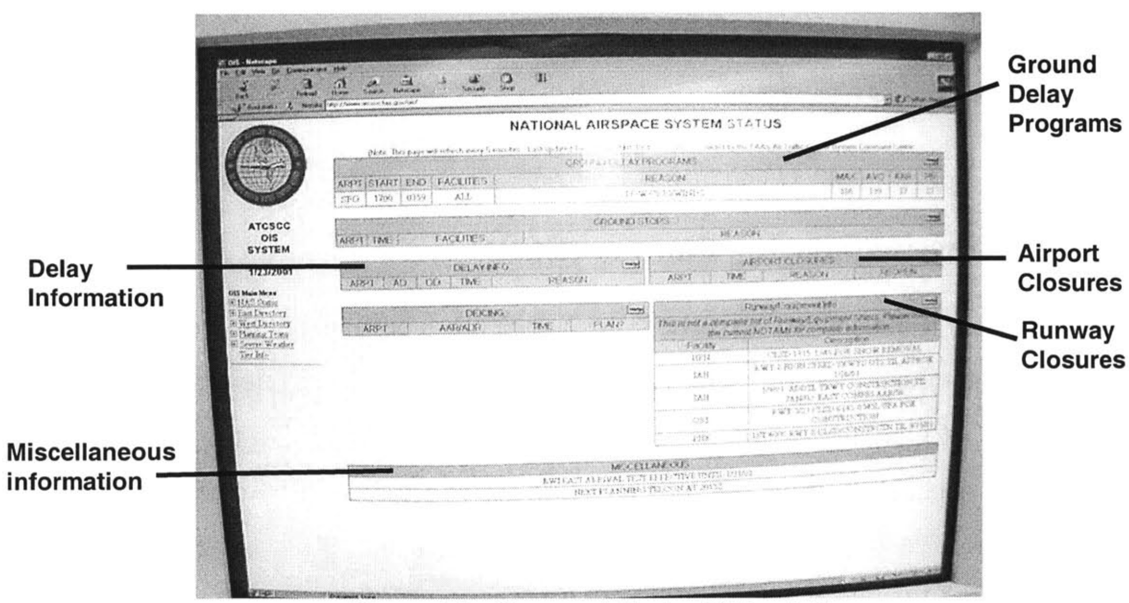

Figure A.5: Command Center OIS website.

A.5 Doppler Weather Radar

The Doppler Weather Radar is used to provide current weather conditions. It is particularly useful to monitor developing thunderstorms. As the storm becomes more severe, the color on the display changes from cool blues and greens to oranges and reds. This tool also supplements information retrieved from the facility meteorologists. Figure A.6 is a picture taken of the Doppler Weather Radar depicting thunderstorms along the East Coast of the U. S.

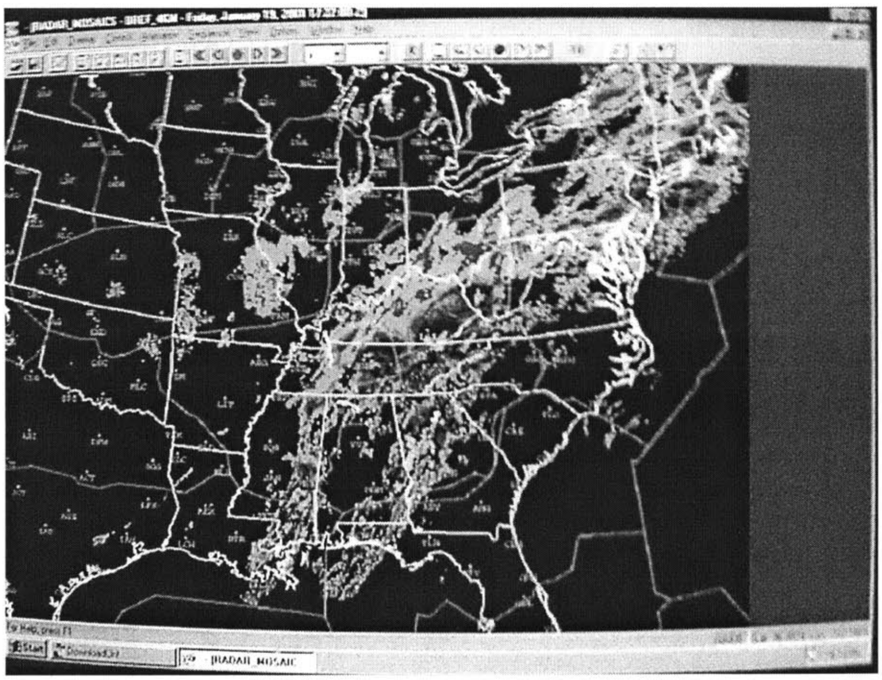

Figure A.6: Doppler Weather Radar.

A.6 Departure Sequencing Planner (DSP)

The DSP is a tool used exclusively in the New York facilities that will eventually replace the time-consuming APREQ (Approval/Request) procedures now in place. The Center, the TRACON, and each of the major Towers has a DSP tool in the facility TMU. There are four separate bins on the DSP screen to aid in determining the departure line-up:

- **Proposed bin:** In this bin, canned flight plans from the Host are inserted 45 minutes before departure. The Towers also insert new flight plans in the

Proposed bin once they are cleared through the Data Area ("The Pit") at New York Center. The DSP assigns the aircraft a departure window, and the Pit TMC can alter it if needed. The Pit TMC then looks for the flight plan's compatibility with preferential routing (valid departure fix and airway), and once it is compatible, the departure is transferred from the Proposed bin to the Cleared bin.

- **Cleared bin:** This bin reflects the flight plans that have been cleared by New York Center's Pit area. If a change to the flight plan has been made within 15 minutes of the departure time, the Pit TMC will telephone the Tower to reinforce the change.
- **Taxi:** The Tower then inserts a tentative departure line-up of the aircraft that have been cleared to taxi into the Taxi bin.
- **Departure line-up:** This bin reflects the actual take-off line-up as cleared by the Tower. The TRACON monitors this list for predicted departure demand.

The DSP is currently a useful information-sharing tool, allowing a common form of the departure line-up to be shared among all of the facilities in New York as well as the current state of any departing aircraft.

A.7 Integrated Terminal Weather System (ITWS)

The ITWS tool provides the New York TMCs with the most current terminal weather conditions available as well as a 30-minute terminal area weather forecast. This tool combines information from FAA and National Weather Service sensors and radars to provide the most accurate forecasts possible. Among the information available from the ITWS are Airport and TRACON precipitation, storm motion, lightning, temperature, winds, microburst detection & prediction, gust front detection & prediction, and tornado vortex signature. This information is combined into a single situation display that is depicted in Figure A.7.

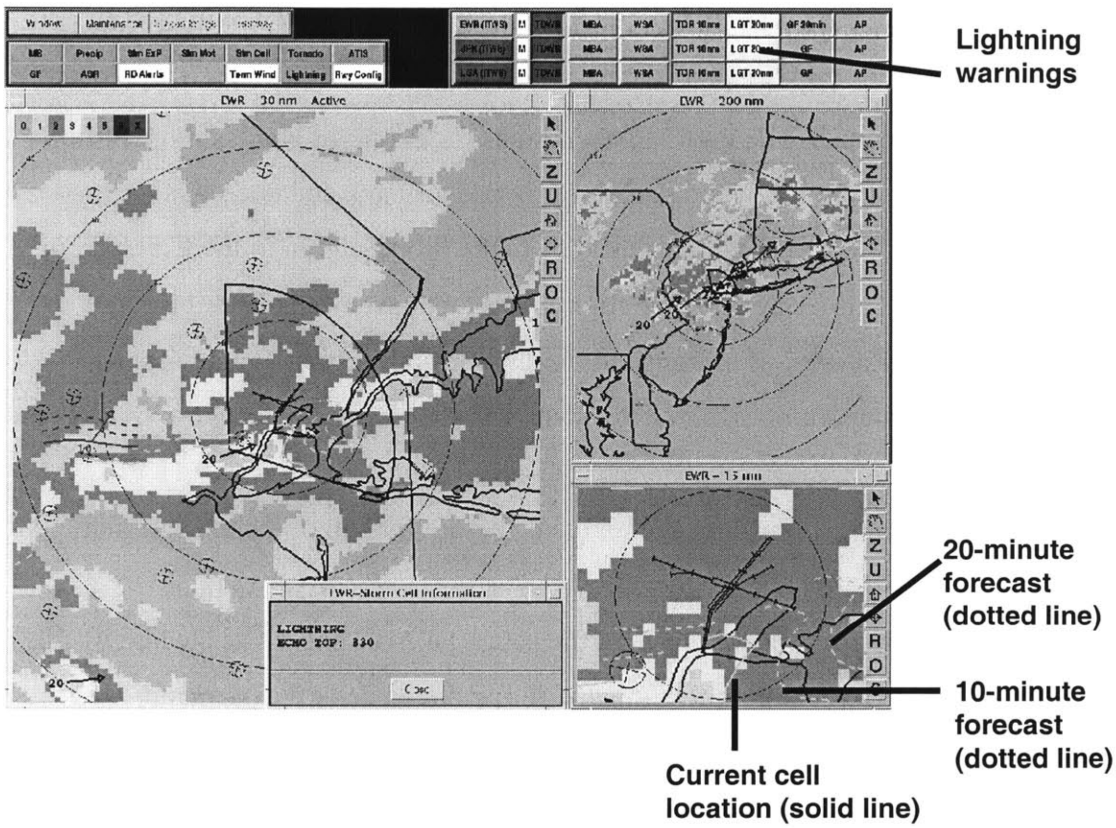

Figure A.7: Integrated Terminal Weather System (ITWS) Display (MIT Lincoln Laboratory, 2001).

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