Video Datacasting:

Chicago Pilot After Action Report

First Responders Group
October 2015

Homeland Security
Science and Technology

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Chicago Pilot After Action Report

HSHQPM-15-X-00122
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Prepared for:	**The First Responders Group Office for Interoperability and Compatibility by Johns Hopkins University Applied Physics Lab**

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Executive Summary

The Johns Hopkins University Applied Physics Laboratory (JHU/APL), under the direction of the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), First Responders Group (FRG), Office for Interoperability and Compatibility (OIC), executed a demonstration and evaluation of a prototype datacasting system installed at the offices of Public TV Broadcasting Station WTTW and operated by the Chicago Office of Emergency Management and Communication (OEMC). This exercise took place on August 12-13, 2015, in Chicago, Illinois. Although the primary exercise had been planned to include an operational scenario involving both land and marine assets of the police and fire departments, it had to be scaled down to a technical demonstration due to the upcoming Chicago Air and Water Show because personnel commitments severely limited Chicago Police Department (CPD) and Chicago Fire Department (CFD) involvement. Fortunately, the test team was able to take advantage of a last minute opportunity to have a separate demonstration of the system to members of the United States Coast Guard (USCG) Station Calumet Harbor and to collect valuable data and observations regarding datacasting coverage and applicability to marine uses. Technical performance of the system and its operational utility were analyzed by the test team from JHU/APL and its subcontractor SpectraRep.

Datacasting is a technology leveraging underutilized capacity in digital television signals to provide secure, targeted broadcasts of data, including voice, text, files, images and video. Data is encoded, encrypted, registered (for access control), and multiplexed with other streams into the digital television signal. Relatively inexpensive datacasting receivers are used to view the encrypted data. Existing digital TV transmission infrastructure (i.e., power, radio frequency equipment, antenna, tower) is used, so datacasting does not add a significant cost to the broadcaster. Using television station infrastructure makes datacasting highly reliable, especially during emergencies.

The August 12-13, 2015, Chicago datacasting pilot was designed both as a demonstration of the technical capabilities of datacasting (coverage, video quality, ease of use) and of its applicability to a number of day-to-day public safety challenges. It was especially important to test video because public safety personnel often use closed circuit TV (CCTV) video to prepare for and respond to emergencies. To demonstrate the day-to-day utility of datacasting, a two-part scenario reflecting potential law enforcement and search and rescue operations was constructed. While datacasting could also be used to support dissemination of aerial data, the cost of providing aerial assets for the demonstration would have been prohibitive. Therefore, aerial assets were not used.

On August 12, the test team executed a demonstration of the datacasting system for the USCG as might be used in a search and rescue or pursuit operation. A datacasting receiver capability was installed aboard a USCG boat, and the boat was driven approximately eight miles from shore on Lake Michigan. For the duration of the exercise, the datacasting system was configured at the OEMC to continuously transmit video from CPD video surveillance assets on shore to the USCG boat, where it was successfully viewed. The USCG noted the datacasting capability would be especially useful for their mission.

On August 13, a two-part scenario was executed with CPD and CFD. In the first part, CPD surveillance cameras were used by law enforcement to track a "suspect" as he fled south on the Lakefront Trail along Lake Michigan. A representative of Motorola, supporting the test team, played the role of the "suspect," while members of the test team observed the test from a CPD boat and a CFD boat at the Chicago Marine Unit in DuSable Harbor. The second part of the scenario was designed to simulate datacasting support for a search and rescue operation on Lake Michigan. In this part of the scenario, a number of CPD video surveillance cameras located along the Lake Michigan shore were trained on Lake Michigan simulating video that might be provided during a search and rescue operation. Because of personnel commitments for the Chicago Air and Water Show (scheduled for August 15-16), the number of officers available to observe the exercise was limited and neither CPD nor CFD boats were able to launch. However, the demonstration was successful. The test team members at the OEMC were able to broadcast alerts and files to both boats in the docks, where the participants in those boats observed high quality video. The participating CPD and CFD officers indicated datacasting capabilities would be a useful tool for their activities.

The tests on August 12-13 met their objectives and provided a clear demonstration of datacasting capability:

(1) All transmissions using the datacasting system – alerts, images, files, and video streams – were successfully received by targeted recipients. Successful receipt was verified by members of the test team and the participating organizations. Reception at the CFD boat was initially very poor; however, after relocating the receiver antenna, all alerts and files were received, and video quality was consistently very good. While the transmission remained strong, reception is dependent on effective receiver antenna configuration and placement.

(2) Although the test team was unable to test datacasting coverage during the August 13 CPD/CFD demonstrations, the ad hoc USCG test on August 12 provided an excellent demonstration of datacasting coverage. Even at eight miles from the shore, video reception remained excellent. Members of the test team, using their own cell phones to measure reception and stream video (YouTube), verified datacasting coverage over Lake Michigan exceeded that of cellular networks.

(3) During the exercise with the USCG, reception quality was evaluated while the boat was moving at different speeds. Note that the standards underlying the datacasting quality do not support signal reception aboard a moving platform; however, the actual capability exceeds the standard. The test team observed consistent, high-quality video reception at speeds of up to 35 knots (nautical miles per hour). There was, however, occasional disruption, apparently due to "chop" (i.e., short-period water waves causing a rough surface making the boat move up and down). At speeds greater than 35 knots, the system was no longer able to consistently receive high quality data.

(4) All participants commented positively regarding the usefulness of being able to receive data up to several miles offshore via the datacasting system. In addition, all participants – USCG, CFP, CPD – expressed a strong desire for a capability to

transmit videos recorded aboard the boat back to assets ashore. Datacasting does not currently fill this particular need.

Equipment used in both demonstrations remains in place. Chicago OEMC has the ability to "push" data and video, while the USCG, CPD and CFD boats all have the ability to receive datacasts. All organizations were encouraged to continue to use the system, to record observations and to provide additional feedback to the test team. The August demonstrations provided further validation of the capability and utility of datacasting for public safety, search and rescue and law enforcement. JHU/APL will continue to collect data and perform additional analysis to better define and evaluate the potential uses of this capability and how it may be integrated within the broader public safety communications architecture.

1   Introduction

The U.S. Department of Homeland Security (DHS) is committed to using cutting-edge technologies and scientific talent in its efforts to make America safer. The DHS Science and Technology Directorate (S&T) is tasked with researching and organizing the scientific, engineering and technological resources of the United States and leveraging these existing resources to develop technological tools to help protect the nation. The DHS S&T First Responders Group, Office for Interoperability and Compatibility, administers the Video Quality in Public Safety (VQiPS) program, which is concerned with all facets of the use of video in the public safety field (i.e., law enforcement, fire, emergency medical technicians and associated entities).

- **VQiPS Vision**

  The VQiPS Working Group will create a collaborative environment that accelerates the ability of users to specify and deploy video technology solutions that meet user requirements and improve public safety and Homeland Security Enterprise operations.

- **VQiPS Mission**

  The VQiPS Working Group creates knowledge products, fosters a knowledge-sharing environment, and supports research, development, testing, and evaluation for enhanced video quality through measurable, objective, and standards-based solutions across the full spectrum of video-use cases for the public safety community.

- **VQiPS Background and Goals**

  The VQiPS initiative, which started in 2008, is managed by the VQiPS Working Group that is made up of a multi-stakeholder partnership between the Department of Homeland Security's (DHS) Science and Technology Directorate, the U.S. Department of Commerce's Public Safety Communications Research Program (PSCR), public safety practitioners, the private sector, standards development organizations and the global research community. VQiPS gathers input from practitioners and video experts and delivers unbiased guidance and educational resources that help the first responder community clearly define and communicate its video quality needs. In the beginning, the group sought to accomplish two tasks: educate end users about video system components and provide knowledge tools to help end users define their own use case requirements.

  VQiPS accomplished these goals with multiple technical reports and the development of the VQiPS Web Tool (http://www.pscr.gov/outreach/vqips/vqips_guide/) and the Video Quality Standards Handbook (http://www.firstresponder.gov/TechnologyDocuments/Digital%20Video%20Quality%20Handbook.pdf).

Moving forward, VQiPS will support the build-out of the Nationwide Public Safety Broadband Network (NPSBN) by developing video-over-broadband materials and guides, as

well as connect to FirstNet to provide technical information and feedback regarding video over LTE.

Identifying and supporting best practices in the efficient distribution of video is consistent with the VQiPS program goals.

1.1   Datacasting Capabilities

The TV broadcast industry recently completed an evolution from analog to digital signal transmission. The digital broadcast signal is composed of time division multiplexing (TDM) or time-division-multiple-access (TDMA) slots, with each time slot containing an Internet Protocol (IP) packet that supports the use of IP networking technology at the entry and destination nodes (i.e., TV station and TV receiver). The signal is transmitted at a constant rate of approximately 19.39 Mbps. However, the TV signal does not consume the total bit rate. Null packets are transmitted to maintain the constant bit rate. Those null packets can be replaced with data content not intended for television viewing without degrading the received television signal.

Datacasting (i.e., data broadcasting) takes advantage of the under-utilized bit rate to transmit various digital data types, including voice, streaming video, images, messaging, files and documents. The data may be encrypted to provide privacy, registered to enable targeting, and may include forward-error protection to enable a high quality of service. While the nature of datacasting is a one-way, wide-area broadcast to all receivers in the coverage area, datacasting allows for information, including video, to be transmitted to specific individuals, groups of individuals or every receiver for processing data.

A multiplexer is used to integrate the various data types with the TV signal prior to transmission. The multiplexer input is typically provided via a data server that connects to various data sources (e.g., information repositories or databases, closed-circuit TV monitors, voice systems and messaging systems). The server provides the ability to select the data source(s) for transmission over the air. At the receiver end, an antenna and an inexpensive dongle plugged into the Universal Serial Bus (USB) port enables any computer or laptop to receive the TV signal encoded data. Linux-based datacasting software installed on the computer extracts the datacasting information from the rest of the Digital Television (DTV) signal and presents it in a form understandable by the end user.

As with other secure wireless capabilities, transmissions via datacasting are secured via encryption and access control. Datacasting is amenable to a number of encryption and access control implementations. Compliance with Health Insurance Portability and Accountability Act (HIPAA) or other guidelines is achieved via encryption and access control, but was not explicitly addressed in this exercise or in this report.

Because it uses television station infrastructure, datacasting is highly reliable, especially during emergencies. For example, during the 2013 Boston Marathon, cellular and landline communications were saturated and largely unavailable for at least 90 minutes after the bombing [1]. Following the 2011 Mineral Virginia Earthquake, cellular and landline phone communications were saturated for the first 30 minutes [2]. During 2005 Hurricane Katrina [3] and 2012 Superstorm Sandy [4], cellular and Internet communications were

severely affected for an extended time. It should be noted that, during Hurricane Katrina, only about 28 percent of TV stations experienced downtime in the storm zone [5]. Television station downtime could result from damaged transmission towers, flooded transmission equipment or the loss of power for prolonged periods that exceeded back-up generator capabilities. Therefore, as long as the TV station has a source of power with an intact transmission tower and equipment, datacasting should be a reliable means of communicating emergency information to first responders.

Datacasting has the potential to provide significant benefit to first responders, including law enforcement. Potential benefits include the following:

- Because broadcast TV signals are widely available geographically in urban, suburban and rural environments, datacasting coverage typically exceeds that of cellular systems and land mobile radio. For example, digital TV broadcasts can cover 10,000 square miles or more, which is orders of magnitude greater than cellular coverage. TV broadcasts not only can reach remote areas, but also urban "dead spots" not covered by existing public safety communications systems.

- Because datacasting uses the infrastructure provided by a broadcast TV station, it is a highly reliable and available method of communication. In contrast, cellular coverage is often lost for significant periods of time following emergency events (see examples in previous paragraph).

- Datacasting is not subject to congestion during emergencies. Unlike other public safety communications systems, datacasting does not need to share infrastructure or capacity with commercial communication networks.

- Datacasting can be used to multicast data to a large number of users for the same cost as the transmission of data to a single user. Datacasting can make more efficient use of available bandwidth and possibly reduce the cost of commercial service to the agency by reducing the overall demand for bandwidth.

- Datacasting leverages a system designed primarily for the transmission of high quality video and audio streams. Thus, it has the innate ability to address the public safety community's desire for high quality audio and video data transport.

- Datacasting is relatively inexpensive to implement and operate. Many public broadcasting TV stations are already configured to support datacasting. The existing digital TV transmission infrastructure (i.e., power, radio frequency equipment, antenna, tower) is used, so datacasting does not add a significant cost to the broadcaster.

Datacasting has been used by the Clark County School District Police Department in Las Vegas, Nevada,[1] to broadcast video from their extensive closed circuit television (CCTV) system via the Nevada Public Television Station KLVX. As implemented in Clark County, datacasting is a reliable and useful system that provides operators with ready access to critical data, ensures the timeliness of that data and enables dependable transmission of

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[1] See: http://www.spectrarep.com/pr05132010.html

that data across the entire county – something local cellular networks and land mobile radio (LMR) cannot achieve. In the event of a major event at a school anywhere in Clark County, first responders would have access to critical and current information. In addition, datacasting provides a powerful emergency broadcasting capability that can be leveraged in case of a crisis. SpectraRep is the primary commercial firm that has promoted the use of datacasting. Given the growing interest in datacasting as a distribution method for video, it is the desire of the VQiPS program to further investigate and study the viability of this technology and potential application to the NPSBN.

For this DHS project, JHU/APL is leveraging knowledge gained under an existing task with the Department of Justice (DOJ) to explore the technical aspects and value of datacasting as a mechanism to distribute video to multiple users via the public television broadcast spectrum. This includes knowledge gained from a baseline evaluation of the operational use of datacasting in the Clark County school system mentioned above. The goal for the DHS task is to develop a baseline understanding of the datacasting technology from the participants, including understanding the technology installation, the end user perspective on usage and the concept of operations in which it is used.

The second pilot demonstration of the DHS-sponsored datacasting project was executed in Chicago, Illinois, with the City of Chicago Office of Emergency Management and Communications (OEMC), and supported by the Chicago Police Department (CPD) and the Chicago Fire Department (CFD). Chicago OEMC manages incidents, coordinates events, operates communications systems and provides technology to support city services to strengthen their respective missions of protecting lives and property in Chicago.2 Datacasting equipment was installed at WTTW enabling data to be broadcast in its digital television signal of WTTW. WTTW, which operates on virtual channel 11 (UHF digital channel 47), is the primary Public Broadcasting System (PBS) TV station servicing Chicago. It shares offices in the North Park neighborhood of Chicago with classical music radio station WFMT (98.7 FM), and transmits from atop the Willis (formerly Sears) Tower in Chicago's Loop district.

The JHU/APL test team, including its subcontractor SpectraRep, was also able to perform a demonstration exercise of the pilot system for the United States Coast Guard (USCG) Station Calumet Harbor. Datacasting transmission equipment remains installed at the offices of OEMC and WTTW. CPD, CFD and USCG each have a datacasting receiver capability. These organizations were encouraged to continue to use the equipment in the upcoming months so that the JHU/APL test team would have the opportunity to collect additional data.

Additional technical details of the datacasting process are provided in Appendix A.

1.2   Goal of this Report

The goal of this report is to provide an After Action Report for the datacasting pilot that took place in Chicago, Illinois, on August 12-13, 2015. This pilot involved several agencies, including WTTG, the Chicago OEMC, CPD, CFD and the USCG. A scenario

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2 http://www.cityofchicago.org/city/en/depts/oem.html

was developed to demonstrate the operational utility of datacasting during representative law enforcement and search and rescue operations. However, CFD and CPD commitments associated with the Chicago Air and Water Show on August 15-16 limited their participation. Thus, the operational aspects of the test were reduced, and the emphasis was placed on demonstrating technical aspects of the system. Fortunately, JHU/APL was able to add a USCG boat demonstration, which provided information on datacasting performance offshore and with a moving receiver. The JHU/APL team observed and collected user feedback during these tests. This report documents these tests, including the technical issues and user feedback.

The goals of the demonstration were to demonstrate the following:

(1) The technical capabilities of datacasting;

(2) Datacasting's utility to emergency management;

(3) The ability to reliably broadcast large files;

(4) The ability to stream real-time video to multiple users; and

(5) The ability to simultaneously broadcast data to multiple agencies [6].

2   Chicago Datacasting Pilot Demonstrations

2.1   USCG Station Calumet Harbor

Members of the test team arrived in Chicago on August 12, 2015. The tasks originally planned for that day included performing an equipment checkout and dry run of the scenario before executing the demonstration on August 13. However, due to other work-related commitments, Chicago OEMC and CPD were unable to support the August 12 checkout and preliminary testing. Fortunately, the JHU/APL test team was able to take advantage of a last minute opportunity to demonstrate the system to representatives of the USCG. Because a similar system implemented at WGBH in Boston had been successfully demonstrated before members of the USCG station in Massachusetts, there were already efforts to include a demonstration for the USCG in Chicago. An agreement with the USCG Station Calumet Harbor was achieved just a few days before the Chicago test, but the USCG was only available to participate on August 12. While the demonstration for the USCG was purely a technical demonstration, this allowed the JHU/APL team to test datacasting usage with moving boats several miles offshore. Therefore, this provided an important opportunity for interaction with and operationally oriented feedback from USCG personnel.

2.1.1   USCG Datacasting Procedures

Due to the minimal lead-time for the USCG agreement to participate in the exercise, no formal test plan could be developed before the exercise. Nonetheless, the test team was able to execute a number of ad hoc tests to measure and verify critical aspects of the datacasting system. They demonstrated the capabilities and limitations of the system sufficiently to

facilitate operationally oriented feedback from the USCG. In addition, this enabled the USCG to continue to use the system following the August exercise to further collect performance data and user feedback. Specific activities executed during the August 12 test include the following:

(1) Members of the test team provided a discussion of datacasting and a demonstration to the USCG Station Calumet Harbor, with representatives from the DHS sponsor and the National Institute of Justice in attendance. The test team explained datacasting and its capabilities. A live demonstration of the system was then executed using two laptops, both of which had the SpectraRep IncidentOne software installed. One laptop was used to generate an alert with files attached to it. Information contained in the alert was transmitted via the Internet to the WTTW public TV station, which was then broadcast within the station's digital television signal (i.e., datacast). The transmission was successfully received in the second laptop. Following this demonstration, there was significant discussion of USCG data needs.

(2) Following the demonstration, the laptop with a datacast receiver was placed aboard a USCG vessel (Figure 1). An antenna for capturing the station's broadcast signals was fastened to the mast and signals from the antenna were input to the laptop via a dongle inserted into one of its USB ports.

(3) Because no Chicago OEMC personnel were available to generate alerts or disseminate data files, the system was configured in advance of the USCG test to continuously broadcast real-time video from one of the CPD surveillance cameras. Prior to sailing, the test team confirmed the boat laptop was successfully receiving the video. Figure 2 contains a photograph of the interior of the test boat showing the configuration and placement of the datacasting laptop.

(4) The crew on the USCG vessel included most of the test team, as well as USCG personnel. The USCG crew piloted their vessel approximately eight (8) miles into Lake Michigan before returning to the dock. The map and aerial view in Figures 3 and 4, respectively, are provided to identify the location of the test boat launch point at USCG Station Calumet Harbor.

Figure 1: USCG vessel used for datacasting demonstration.

Figure 2: Interior of the USCG vessel used during the August 12 datacasting demonstration. Note the laptop used to receive the datacast is on the table.
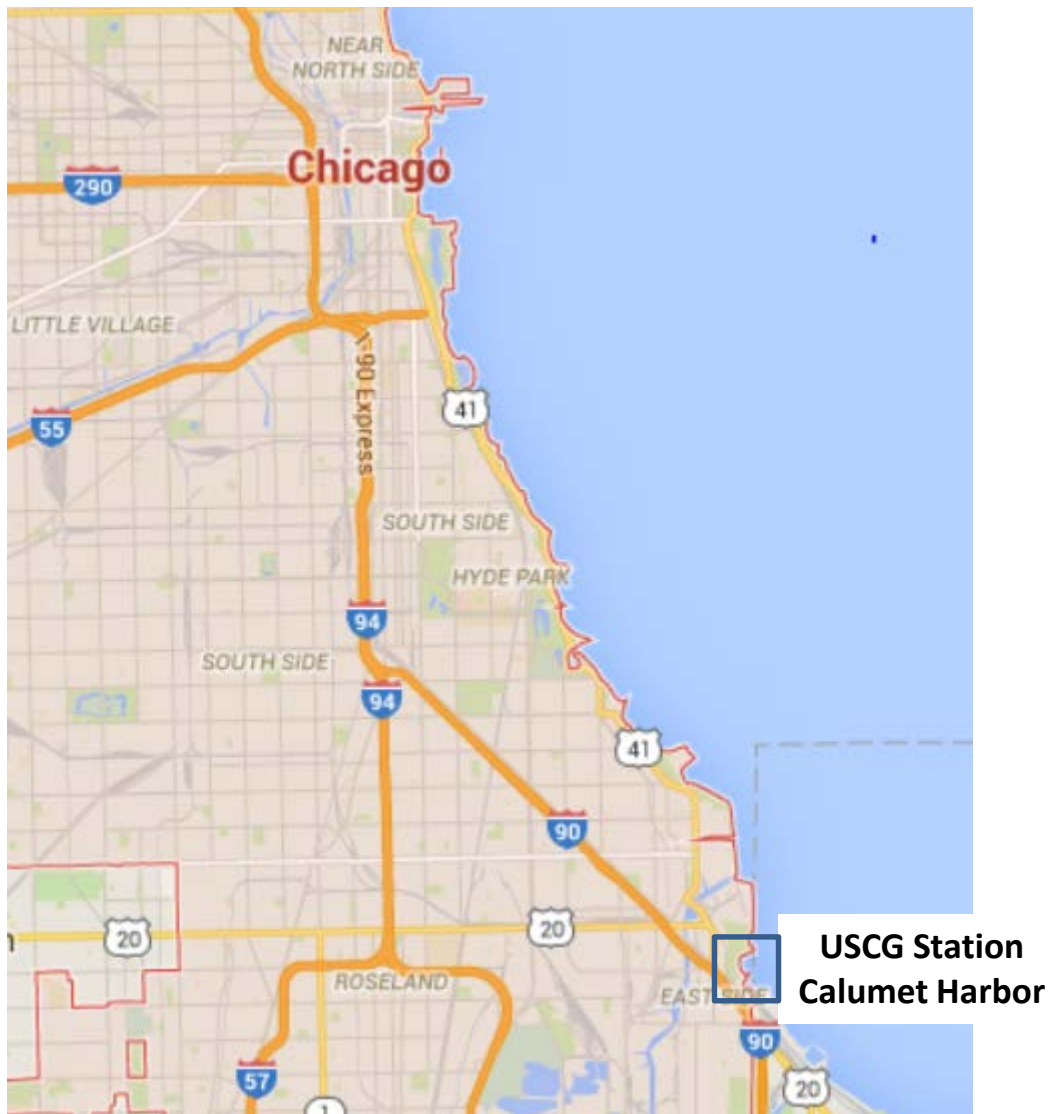
Figure 3: Map showing USCG Station Calumet Harbor, Lake Michigan, on the south Chicago lakefront (courtesy of Google Maps).
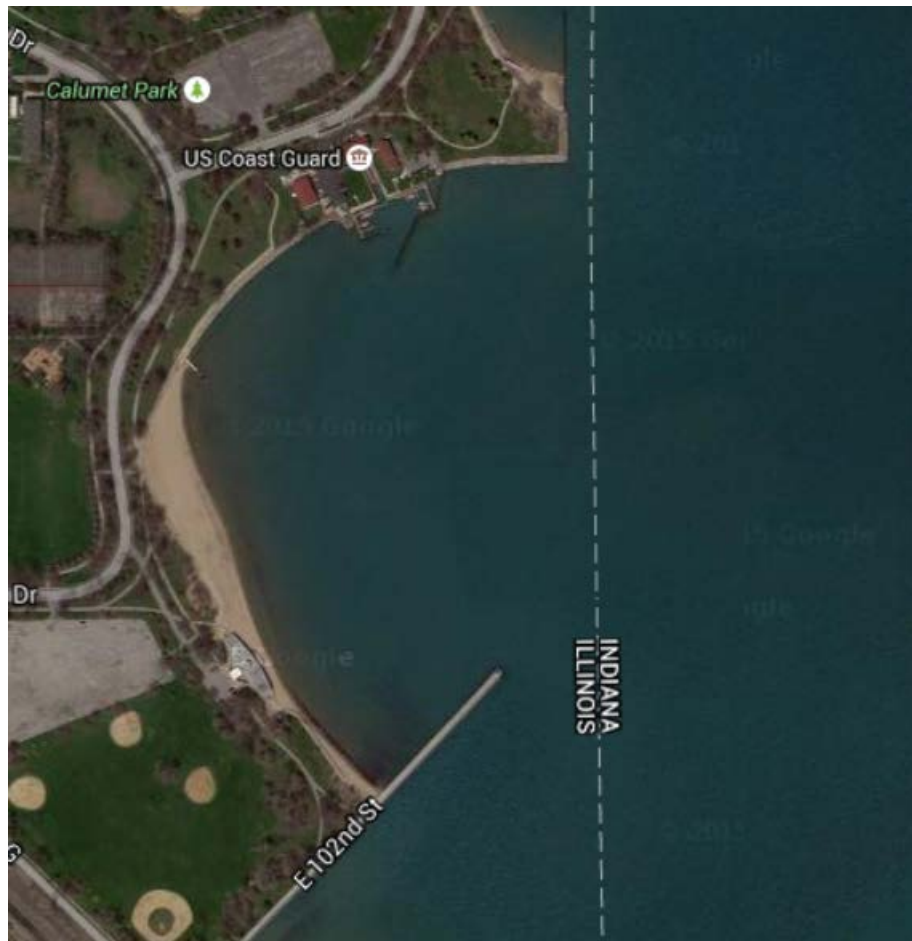
Figure 4: Aerial view of USCG Station Calumet Harbor (courtesy of Google Maps).

(1) Members of the test team continuously monitored the video received via the datacasting system and assessed its quality. In addition, USCG crew periodically verified the video quality. While on Lake Michigan, members of the test team monitored their cell phone reception and periodically attempted to stream YouTube videos to compare the performance of their commercial cellular networks to the datacasting system on the boat. When the boat was eight miles offshore in Lake Michigan, cellular services were no longer available. However, datacasting information continued to be successfully received.

(2) Datacasting reception was also tested with the USCG boat moving at speed. The USCG crew accelerated the boat to speeds of over 35 knots (nautical miles per hour) to assess datacasting performance aboard a moving platform.

2.1.2   Exercise Results

The following results were achieved during the exercise with the USCG.

(1) Members of the USCG crew and test team had cellular phones operating on the Sprint, AT&T and Verizon networks. These commercial cellular services were lost

when the boat was about six (6) miles from the shore. However, high quality video reception from datacasting was maintained as much as eight (8) miles offshore (the maximum distance tested).

(2) No significant differences in video reception between the datacasting system and the cellular networks were observed prior to the loss of cellular reception. However, as video could only be downloaded via cellular on a periodic basis because test team members were occupied making other observations, it is possible that video reception via cellular was worse than observed.

(3) Datacast video quality was maintained at boat speeds of up to 35 knots. At speeds above 35 knots, there was a substantial reduction in the quality of the video reception. At speeds less than 35 knots, there were occasional reductions in video quality due to "chop" (i.e., short-period water waves resulting in increased vertical motion of the boat). For the most part, the waters of Lake Michigan were calm on the day of the exercise. Thus, it is possible that reception aboard a moving platform would be worse on a day in which the waves were higher.

In addition to the results recorded above, the USCG provided the test team with the following input:

(1) The vast majority of USCG operations on Lake Michigan occur in close proximity to the shore. USCG boats very rarely operate as far as eight miles from the shore.

(2) Search and rescue operations are the primary concern of the USCG in Chicago.

(3) USCG members expressed a strong desire for video and images from aerial assets, including helicopters and Unmanned Aerial Vehicles (UAV). The datacasting capability installed in the USCG boat could be used to receive targeted videos from CPD aerial assets, but this was not tested during the pilot.

(4) USCG expressed an interest in having navigation data transmitted to boats and integrated into the shipboard systems. While datacasting could be used to transmit such data, integration of that data would necessarily involve other systems.

(5) Although the primary mission of the USCG in Lake Michigan is search and rescue, they are also involved in interdiction operations. Transmitting information regarding boats, including ownership and registration status, would be useful in assessing tactical situations prior to boarding. It would be useful to know prior to boarding a vessel whether the situation was something simple like "boating under the Influence" versus something potentially more dangerous. Another area of USCG concern is human trafficking. Because of reports of Eastern European gangs conducting human trafficking across the U.S. northern border, the USCG could benefit from knowing a priori who is operating boats they need to board.

(6) USCG expressed an interest in having a capability to transmit images from the boat back to the shore. Currently, when crew members want to transmit pictures or video back to the shore, they use their cell phones. However, datacasting currently does

not provide a capability to either capture video or images aboard a ship to be transmitted back to the shore.

The laptop and antenna used to receive datacasting broadcasts were left with USCG Station Calumet Harbor. Thus, this system will continue to provide the USCG in Chicago with the ability to receive video and other data from Chicago OEMC. As it is also relatively easy to configure a laptop to operate the SpectraRep IncidentOne software, they will also have the opportunity to generate alerts and transmit data, including video clips. Real-time video streaming would, however, require additional hardware. It is hoped that the USCG will exercise the system in coming months to develop additional insights and report back to the JHU/APL test team.

2.2 Lakefront Trail/Lake Michigan Scenario

On August 13, 2015, the prototype datacasting system testing was executed along the Chicago shore of Lake Michigan. During the test, incidents were generated, and data and real-time video were selected for transmission at the Chicago OEMC. Data was encoded and multiplexed into the digital television signal from WTTW, and received aboard two boats belonging to CPD and CFD, respectively. The original plans involved simulations of a "fugitive" fleeing along Lakefront Trail, and a search and rescue operation for a boat in distress on Lake Michigan. However, due to personnel commitments by the CPD and CFD associated with the Chicago Air and Water show, an abridged version of this test plan was executed instead.

2.2.1 Test Planning

Planning for the event began in April 2015, when representatives of DHS and JHU/APL met with representatives of CPD to discuss datacasting, identify potential demonstration scenarios and develop a plan for defining integration needs.

Equipment was installed at WTTW and the Chicago OEMC in early June. A successful test was performed before representatives of DHS and the City of Chicago Office of the Mayor on June 23, 2015.

During July and early August, operational scenarios were constructed to represent a more operationally focused evaluation. At the request of the CPD, the scenarios included maritime operations and were designed to simulate a search and rescue operation. In addition, a test scenario was added to simulate pursuit of a "suspect" along the Lakefront Trail. This second scenario was added to reduce the risk that the first test might not be executed due to the absence of required assets, such as a boat to track on the Lake or video from over Lake Michigan. The detailed test plan is available in Appendix B.

2.2.2 Equipment checkout

The planned equipment checkout and exercise had to be abridged due to limited availability of CFD and CPD personnel. Representatives of Motorola Corporation, working for the Chicago OEMC, verified equipment operation prior to the test. In addition, members of the test team supporting the previous day's demonstration for USCG Station Calumet Harbor were able to verify system performance.

2.2.3 Exercise Description

The scenario was planned for execution along a stretch of the Lakefront Trail so video cameras along the shore from East Division Street north to East Schiller Street could be used. These cameras were selected because they could be directed to provide video of events on Lake Michigan. CCTV cameras were located at East Division, East Goethe, East Banks and East Schiller Streets (camera locations are within the upper blue rectangle on the map in Figure 5). Boats from the Chicago Marine Unit were located at DuSable Harbor (the blue rectangle near the bottom of the map in Figure 5). The original plan was to drive the boats north to a point in Lake Michigan within view of the cameras between Division and Schiller Streets.
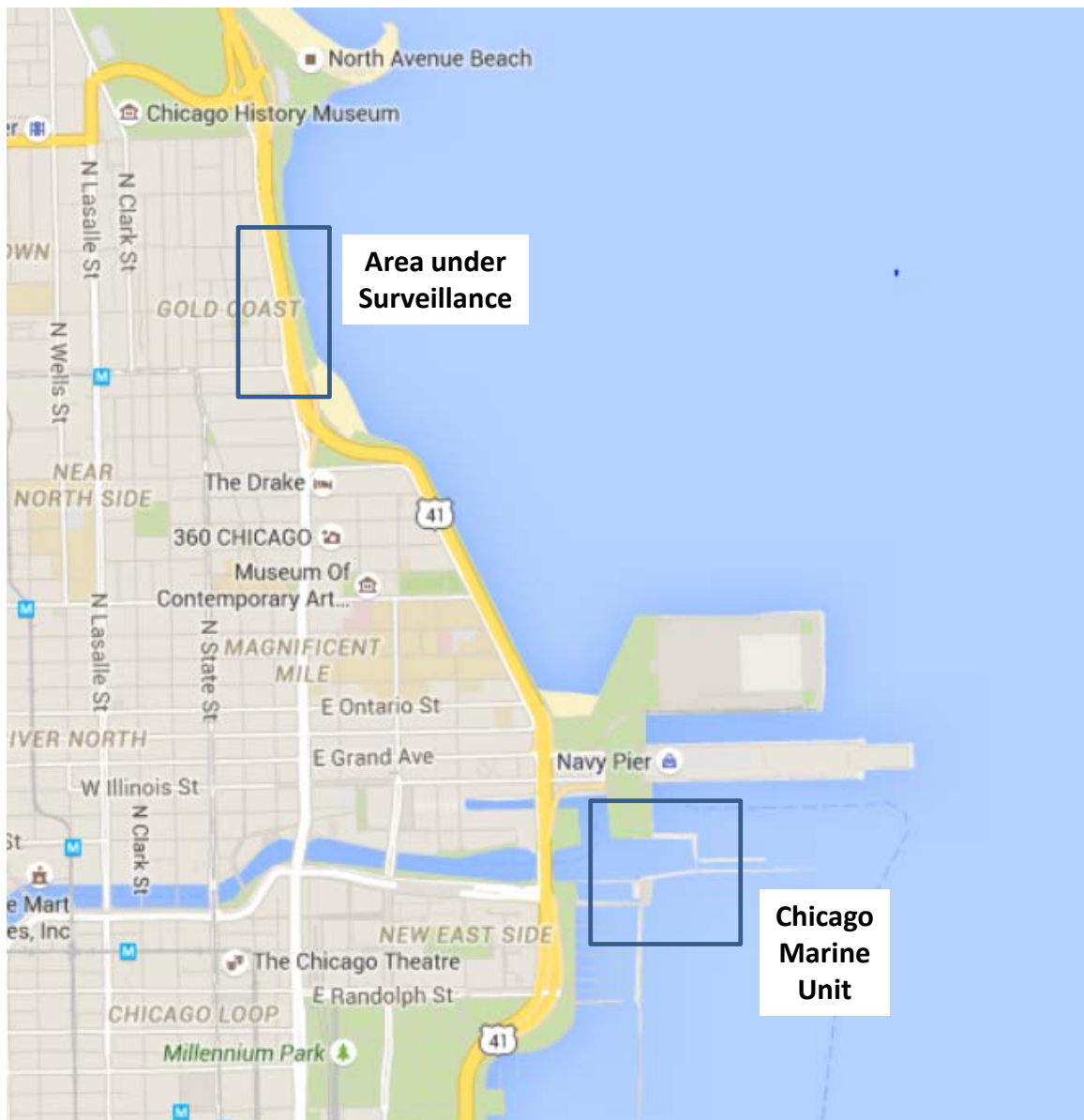

Figure 5: Map showing the City of Chicago Marine Unit at DuSable Harbor. The area under CCTV video surveillance is on North Avenue Beach.

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2.2.4 Observations from the CPD boat

A representative from the test team observed the exercise by using the IncidentOne datacasting system aboard a CPD boat docked in DuSable Harbor at approximately the point where the Chicago River empties into Lake Michigan. CPD Sergeant Hajdu, as well as Tommy Melendez and David Olson from the CPD Information Technology (IT) Department, supported and observed the exercise. Due to the commitments associated with providing security for the Air and Water Show, the CPD boat was unable to leave the dock, and the number of actual CPD operators available was limited. Figure 6 is a photograph of the CPD boat used in this exercise.

Figure 6: CPD boat used in the August 13 datacasting exercise. Due to limited availability of CPD personnel, the boat remained dockside during the exercise.

IncidentOne software was installed on a fixed Motorola computer workstation. A representative of Motorola Corporation affixed an antenna to the boat in the days prior to the test. Datacasting reception capability was tested prior to the arrival of the test team in Chicago.

In addition to test team members on the CPD boat and the CFD boat, other members of the test team remained in the OEMC to generate alerts and push data. For the duration of the test, video from the four CPD surveillance cameras stationed between East Division Street and East Schiller Street was continuously streamed via the datacasting system. Figure 7 illustrates the workstation showing four videos displayed simultaneously. The quality evident in the photograph is representative of the data quality actually achieved during testing aboard the CPD and CFD boats, as well as the previous day aboard the USCG boat.

Figure 7: Motorola workstation showing video from four CCTV cameras.

As part of the exercise, test team members located in the OEMC generated test alerts and appended files to the transmission. Both the alerts and the files were successfully received aboard the boat. Figure 8 is another photograph of a workstation screen with four video streams, but this time the bottom of the screen shows the scrolling text alert.
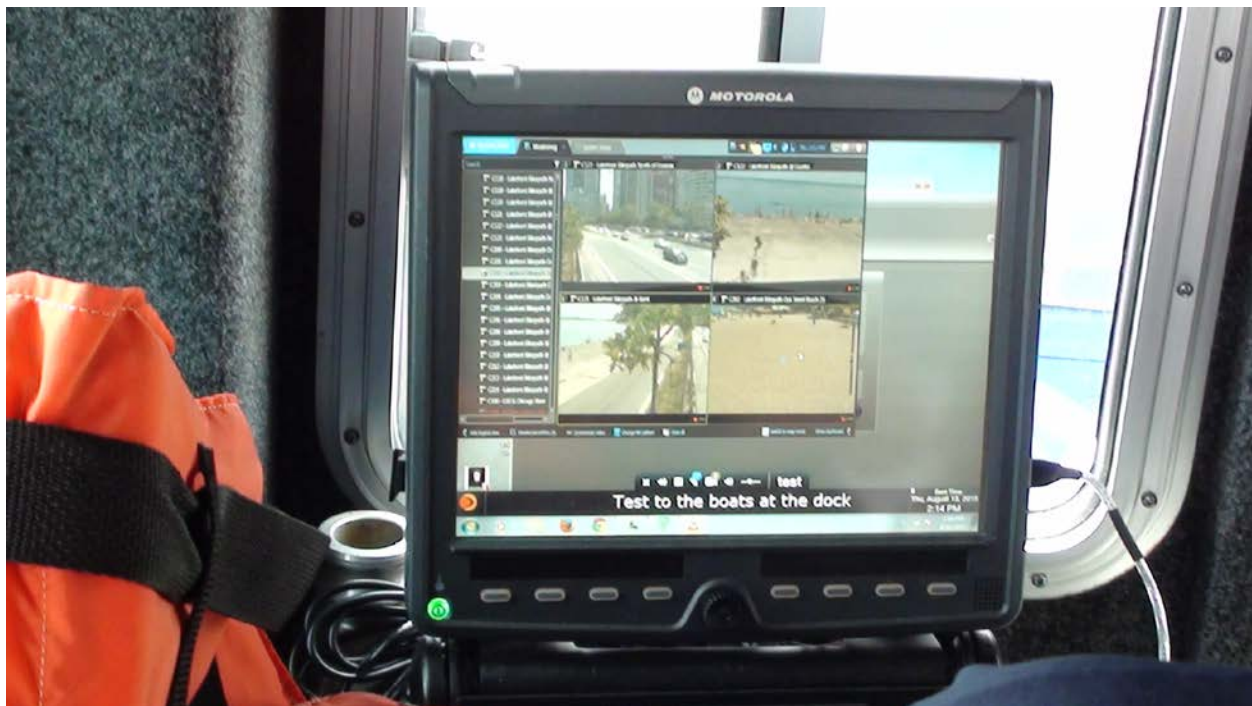

Figure 8: Motorola Workstation showing both four-camera video and the text alert.

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Three files were appended to the test alert. A test team member confirmed receipt of the files. Figure 9 is a photograph illustrating how one of these datacast files may be viewed on the workstation screen.

Figure 9: Photograph of the Motorola Workstation showing a PDF file successfully received via datacasting.

Due to time and personnel constraints, there was limited feedback from the CPD representatives present during this test. All agreed the data reception, especially the video stream reception, was of excellent quality. There was consensus that datacasting had the potential to provide a useful capability. Without datacasting, the Marine Unit currently needs to call the command center for an oral description of events captured in video. In contrast, datacasting would provide them with the actual video, something they currently lack.

The majority of the Marine Unit's operations are in response to capsized boats, boats on fire and "jumpers" (i.e., people attempting suicide).

The officers expressed a strong desire for a capability to transmit video from the ship, especially data from their forward-looking infrared (FLIR) surveillance camera, back to the shore. However, datacasting does not currently have that capability.

2.2.5   Observations from the CFD boat

A representative from the test team observed an exercise using the IncidentOne datacasting system aboard the CFD Boat Christopher Wheatley (see Figures 10, 11 and 12).

Figure 10: Photograph of the CFD boat Christopher Wheatley in its Lake Michigan dock.

Figure 11: Alternate view of the CFD boat Christopher Wheatley.

Figure 12: Aerial view of the location of CFD boat Christopher Wheatley at the City of Chicago Marine Unit (courtesy of Google Maps).

IncidentOne software was loaded into a fixed Motorola laptop computer aboard the vessel (Figure 13). A USB compatible antenna was affixed to the back of this computer. Members of the test team, with the assistance of the ship's pilot, had to move the antenna to the outside of the ship to achieve acceptable reception.

Figure 13: Photograph of the Motorola laptop on board the CFD boat Christopher Wheatley.

Due to increased personnel commitments associated with the Air and Water Show, no CFD operators were available to observe the test, and there was not a sufficient crew available to drive the boat onto Lake Michigan as originally planned. However, the ship's pilot, Ed Popelas, was extremely helpful and provided useful feedback.

Members of the test team stationed at the OEMC generated alerts and attached three files. Upon adjusting the antenna and affixing it to the outside of the boat, the test team members confirmed that alerts were received, and the attached files could be downloaded onto the computer, opened and read. In addition, team members confirmed the receipt of video from four CPD surveillance cameras (the four cameras located between Division Street and Schiller Street). Reception was consistently of good quality for the duration of the time the antenna was placed outside the boat.

In the absence of CFD operators, feedback was limited to the input of the pilot who, by his own admission, does not normally operate the monitor used for datacasting. He noted his operational experience in the use of data was substantially less than that of the operator who would normally be using the computer containing the datacasting system software. He did, however, observe the exercise and express enthusiasm for the datacasting system. Like the USCG operators the day before, the CFD pilot expressed a desire to transmit video from boat camera systems back to the shore or to other units. However, datacasting currently does not provide that capability.

3 User Feedback and Lessons Learned

During the exercises of August 12-13, 2015, members of the test team had the opportunity to interact with representatives of the USCG, CPD and CFD. The test team derived the following key observations based upon interactions with the participating operators:

(1) Participating organizations agreed that datacasting provided a capability not currently available for marine operations on Lake Michigan. In addition, all observers from these public safety organizations agreed that having a datacasting ability to view remote video provided significant added value to their missions. Video from aerial assets – either organic or belonging to other organizations – would also be especially useful, although this ability was not tested during this exercise.

(2) The participating organizations mentioned their primary operations on Lake Michigan included search and rescue (e.g., responding to capsized boats, boats on fire and "jumpers") and interdiction of human and drug trafficking. Video of these events, if available, would facilitate their operations.

(3) The test team was told there was also a benefit to having information about specific boats. USCG expressed a desire for obtaining information about boat ownership and registration status, which possibly could be determined via video from the markings on the boat. Datacasting could then be used to transmit this information to the USCG and other government entities.

(4) CFD expressed an interest in obtaining and transmitting boat plans and specifications so that they would have this information prior to boarding a "suspect" boat. These data could be distributed via datacasting.

(5) Without datacasting, none of the participating organizations currently have a video or image transmission mechanism other than their cell phones. Therefore, datacasting could definitely support USCG, CPD and CFD missions by providing better dissemination of high quality images or video from a command center. Datacasting reception was excellent when tested up to eight miles from shore.

(6) All participating organizations expressed an interest in being able to transmit video and images from boats back to the shore or to other boats. Datacasting currently cannot be used to provide a backhaul for the data to be transmitted to the command center. Widespread adoption of datacasting in marine public safety may benefit from the provision of a backhaul capability to enable boats on the lake to transmit data to the command center ashore, from which the data could then be widely disseminated.

4 Summary and Conclusions

Under the direction of the DHS S&T FRG OIC, JHU/APL developed, conducted and assessed a demonstration of datacasting technology in support of public safety in Chicago Illinois on August 12-13, 2015. Two sets of exercises were performed, one that included members of USCG Station Calumet Harbor, and the other that included CPD and CFD.

These August exercises were the second in a series of demonstrations designed to demonstrate technical aspects of the datacasting system in an operationally representative context. At the request of the CPD, the Chicago exercises were constructed to emphasize marine operations. Public safety agencies in Chicago, including CPD and CFD, engage in a significant number of search and rescue operations on Lake Michigan, and achieving robust communications with marine assets on the Lake presents significant challenges.

In preparation for the test, representatives of JHU/APL and its sub-contractor SpectraRep (the developer of the datacasting system demonstrated) installed datacasting transmission equipment at the office of WTTW. A data aggregation and control capability (enabling operators to select data for transmission and forward it to the television station for broadcast) was installed at the Chicago Office of Emergency Management and Communications (OEMC). Datacasting receiver equipment was installed aboard marine assets belonging to the CPD, CFD and USCG. The JHU/APL and SpectraRep test team trained representatives of the Chicago OEMC, Motorola Corporation (the OEMC Information Technology contractor), CPD, CFD, USCG and WTTW in the use of the datacasting hardware and software.

The datacasting system was used to continuously broadcast real-time video data from selected CPD surveillance cameras. Members of the test team and the CPD, CFC and USCG were able to confirm continuous receipt of high quality video data. In addition, test team members operating the system from the OEMC were able to successfully generate alerts and transfer data files to the CPD and CFD boats.

As a result of this exercise, JHU/APL and its public safety partners in Chicago were able to reach the following conclusions:

(1) The datacasting system is capable of providing high quality video and other data over water up to ranges exceeding that of commercial cellular networks. Members of the test team confirmed reception of high quality video eight miles into Lake Michigan. There was no commensurate commercial coverage from cell phones on the Verizon, AT&T or Sprint networks.

(2) Although current datacasting standards do not support reception aboard platforms in motion, the test team observed consistent reception at boat speeds of up to 35 knots (nautical miles per hour). At speeds above 35 knots, there was degradation in the received datacast video. There was also occasional degradation in the video at moments of high "chop" (i.e., short period water waves making the boat move vertically).

(3) All the participating organizations agreed that datacasting was capable of significantly enhancing their operations. End users observing the system were impressed by its ability to provide data and stream video to boats on Lake Michigan. Datacasting information about the layout, specifications, registration and ownership of boats could be valuable to first responders. Observers were also interested in receiving video from aerial sources, although this was not tested.

(4) A common theme in discussions with CPD, CFD and the USCG was the desire to be able to transmit images and video from boats on Lake Michigan back to shore or to other units. Currently, crew members depend on their personal cell phones to transmit data back to the shore. Even though the marine units rarely operate out of cell phone coverage, personal cell phones are less than ideal for capturing and transmitting high quality operational video, images or other data. While datacasting currently does not support provision of a return path from the ship to the shore TV station, the value of datacasting to the participating organizations would be greatly enhanced if a backhaul capability could be implemented.

The equipment used in these demonstrations remains in Chicago and it is still operational. JHU/APL is encouraging CPD, CFD and USCG to continue to make use of the equipment so they can collect additional data to measure and document its performance. To enhance the collection of data for more detailed datacasting evaluation, JHU/APL recommends the IncidentOne datacasting system be upgraded to record and maintain metrics describing system use. Specifically, JHU/APL would recommend system capabilities be expanded to enable the system to automatically record how many times it was used, to include a description of what was sent (e.g., real-time video, images, maps, records, etc.) and how many recipients were targeted. To protect privacy, there should be no attempt to record content or the identities of recipients. Maintenance of these records would facilitate understanding of how often the system was used and how it was used, which would facilitate measuring its utility.

5 References

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5. Independent Panel Reviewing the Impact of Hurricane Katrina on Communications Networks, "Report and Recommendations to the Federal Communications Commission," June 12, 2006.

6. http://www.firstresponder.gov/Pages/Datacasting-Public-Safety-Communication-Over-Broadcast-Television.aspx (accessed 21 October 2015).

6 APPENDIX A: Technical Details of Datacasting

Television stations transmit aggregate broadcast streams at a constant 19.39 Mbps data rate. Various programs are multiplexed into the aggregate stream. Often television content will not consume the full data rate, or content can be set to use less than the full data rate. When this is the case, null packets are used to fill the unused data rate (see Figure 14). In datacasting, the null packets are replaced with datacasting information that can be received and interpreted by registered recipients with the required equipment.
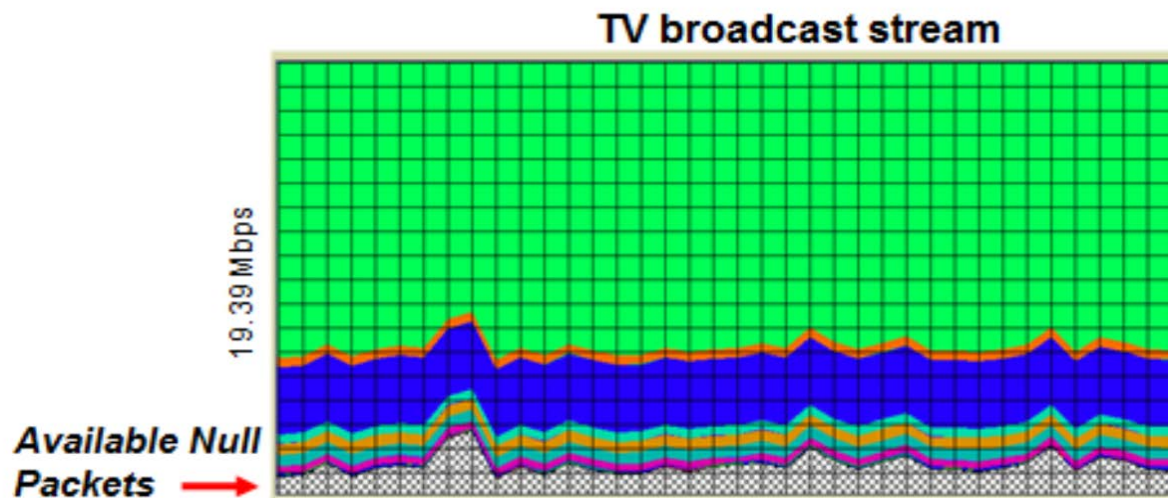

Figure 14: Digital TV Broadcast.

There are three distinct aspects to the datacasting system: (1) information collection and processing; (2) transmission processing; and (3) reception processing (see Figure 15). Optionally, datacasting can be integrated into other systems to create a return path for two-way communication and services. In the prototype system implemented in Chicago, information collection and processing, including decisions as to what information to send and to whom, were performed at the Chicago OEMC. Transmission was performed at the PBS television station WTTW. Reception equipment was implemented in laptops belonging to the various public safety agencies participating in the demonstration.
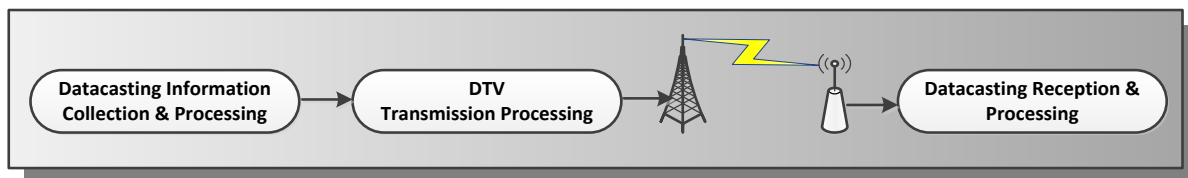

Figure 15: Components of a Datacasting System.

Similar to satellite television providers (such as DirectTV), more than one TV program may be included (i.e., "multiplexed") into one digital television transport stream. Datacasting is an additional program stream in that broadcast channel, but it is not referenced in the Program and System Information Protocol (PSIP), so it does not appear as a "channel" to television sets.

Transport streams are based upon Moving Pictures Experts Group (MPEG)-2 standards. Datacasting information could be embedded within the DTV signal, as represented in Figure 16. In the figure, each packet of the broadcast stream, including the datacasting packet, consists of a 4-byte header and 184 bytes of information.
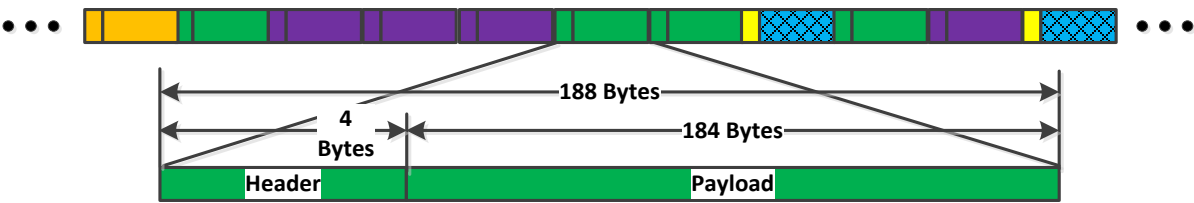

Figure 16: Datacasting within a DTV stream.

The header consists of 32 bits, including a 13-bit Packet Identifier (PID), as shown in Figure 17.

Sync	Error Indicator	Payload Unit Start Indicator	Transport Priority	PID	Transport Scrambling Control	Adaptation Field Control	Continuity Counter
8 Bits	1 Bit	1 Bit	1 Bit	13 Bits	2 Bits	2 Bits	4 Bits

Figure 17: DTV Broadcast Stream Header Format.

Figure 18 illustrates the DTV transport components. The transport consists of services (i.e., television channels), which are made up of events (i.e., television programs) that each have their own elementary service streams (i.e., packetized MPEG 2 streams consisting of video, audio, metadata and service information as examples).
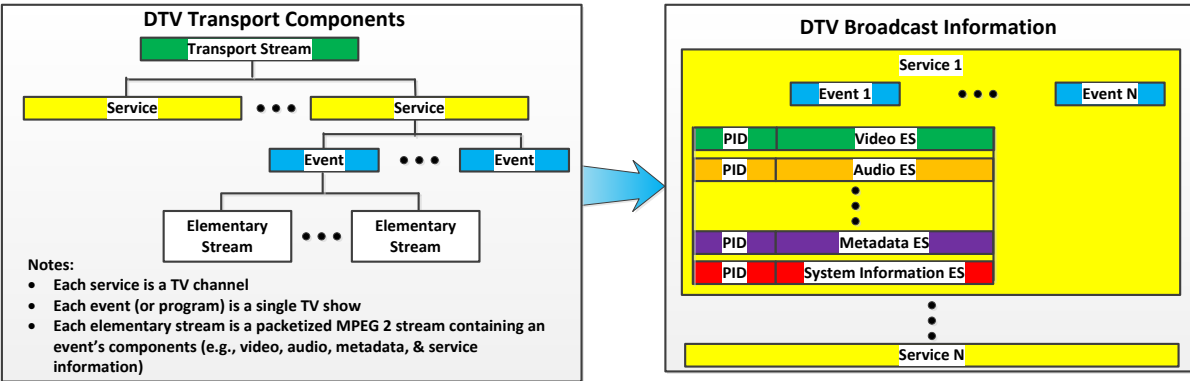

Figure 18: DTV transport components.

The elementary service System Information contains various tables, including:

- Program Association;

- Program Map;

- Network Information;

- Service Description;

- Event Information;

- Conditional Access;

- Bouquet Association;

- Time and Date; and

- Time Offset.

System Information tables include Packet Identifier (PID) assignments to elementary streams, events and services. System Information packets are assigned pre-determined PIDs.

Figure 19 contains a representation of the Datacasting Transport information, which is different from regular television transport. Datacasting does not use the System Information tables and PIDs are pre-assigned to datacasting. PIDs are not included in the System Information tables to prevent DTV receivers from searching for a "ghost" service, event or elementary stream. Datacasting uses "Access Control" to identify PID Assignments, Receiver Assignments, Receiver Group Assignments, Protocol Assignments (e.g., video, file, and messaging assigned to individual and/or group receivers) and key list assignments (for encryption/decryption). Access Control is transmitted on a regular periodic interval.
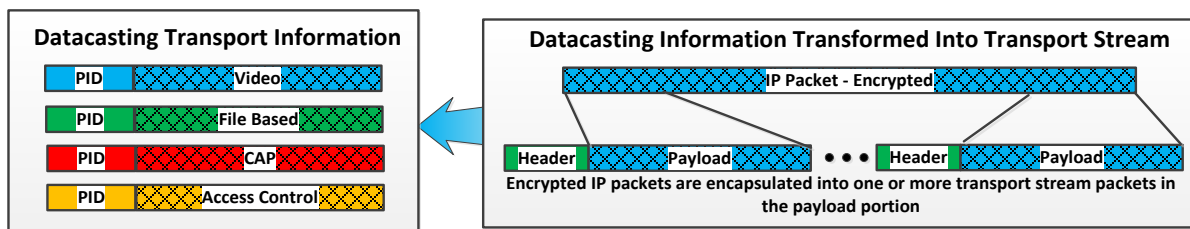

Figure 19: Datacasting Transport Stream.

Datacasting Information Collection and Processing

In general, the datacasting system is configured to incorporate four types of data into the datacasting transport stream as shown in Figure 20:

Real-Time Streamed Data (blue in Figures 19 & 20): Typically, the streamed data may consist of video information such as from a Closed-Circuit Television (CCTV) system. Other streamed data such as audio, weather information and news broadcasts can also be incorporated.

<u>File-Based Information (green in Figures 19 & 20):</u> This information includes documents, images, audio and video clips. It can include other types of digital information including software. Forward error correction (FEC) and carouseling are used to assure all packets are received, even in degraded reception environments.

<u>Message Based Information (red in Figures 19 & 20):</u> Generally, the messages are Common Alerting Protocol (CAP) compliant messaging, allowing messages and notifications to be processed by any CAP compliant alerting platform.

<u>Access Control Information (yellow in Figures 19 & 20):</u> File-based data is used to control registration and access. This information includes receiver registration, receiver group assignments, protocol assignments, key list assignments and PID assignments.
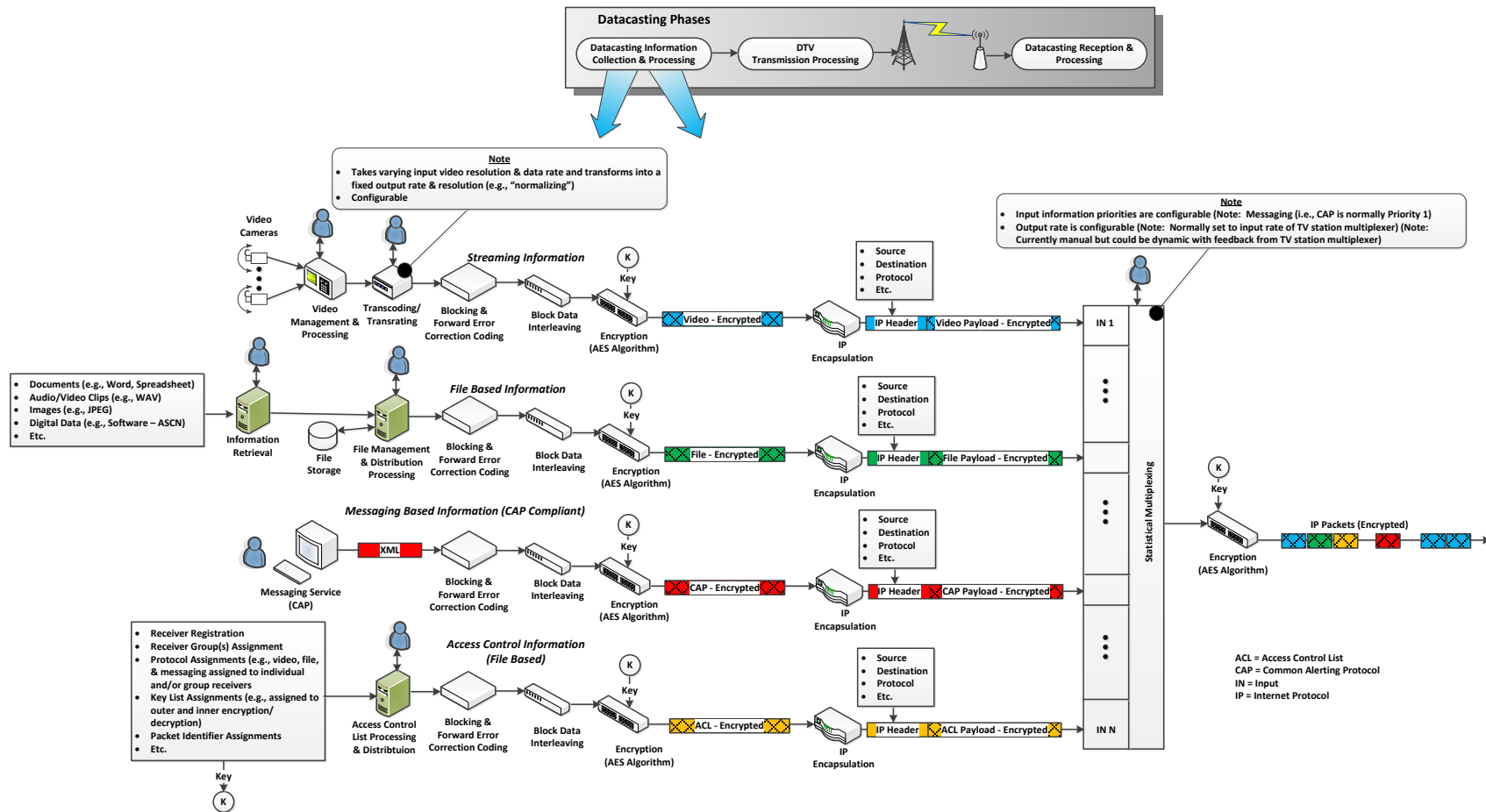
Figure 20: Datacasting Information Collection and Processing.

Some portions of the data preparation process are common for all information types. Data are blocked and forward-error correction[3] is applied. The blocked data are interleaved and encrypted. Encrypted data are encapsulated using IP encapsulation into the MPEG transport packets. Source, destination and protocol data are packaged into the header. The datacasting packets are multiplexed to form a stream that is further encrypted using AES-256.

Transmission Processing

Transmission processing (see Figure 21) consists of merging (multiplexing) the datacasting data stream with the television programming stream(s) as depicted in Figure 22. Prior to the merging, the datacasting stream is processed into DTV transport packets and each transport packet is assigned a PID.
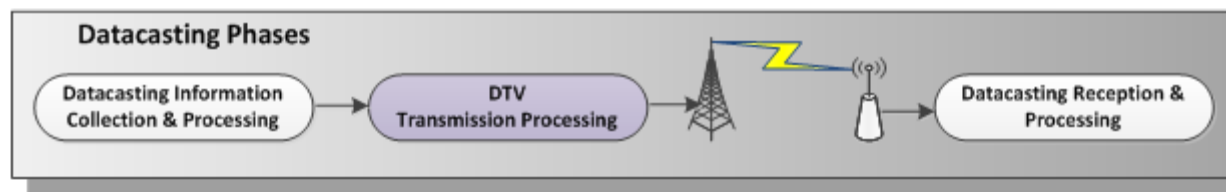

Figure 21: Transmission Processing.

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[3] Forward Error Correction is an encoding technique that protects the transmission and reception integrity of the data. It is used to detect and correct "bit-errors," technical problems that cause an occasional bit in a data stream to be misinterpreted. Provided the rate of errors in a data stream remains below a threshold, the Forward Error Correction Code can correct errors in the data stream. Forward Error Correction is a ubiquitous technique; it has no encryption value.
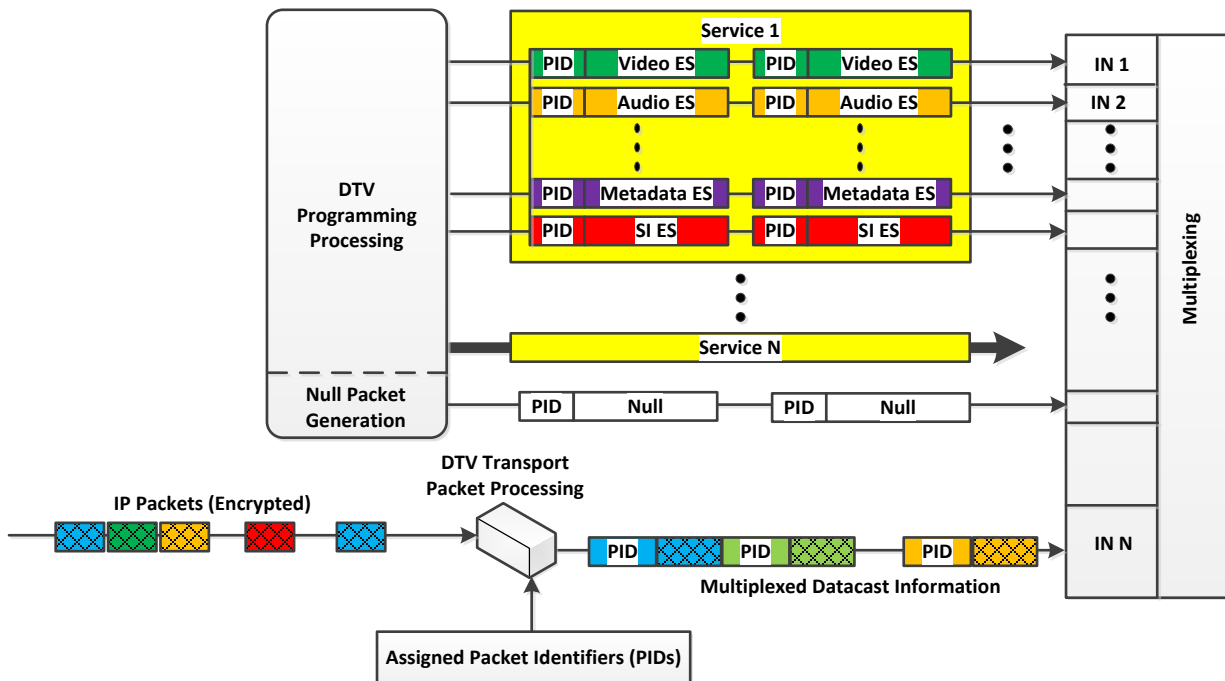
Figure 22: Multiplexing Datacasting and Television Streams.

The overall output rate of the resulting merged stream (including datacasting and programming information) is 19.39 Mbps. Bit rate allocations are configurable. However, under normal conditions, there will be approximately 1-2 Mbps available for datacasting. This bit rate can be increased should conditions warrant it. Maximum bit rate is currently set manually. In the future, it may be possible to enter the information electronically into the information collection statistical multiplexor, which would enable the system to dynamically re-allocate the bit rate.

Null packets are required to maintain a constant 19.39 Mbps bit rate.

Figure 23 depicts the functions performed on the multiplexed signal through transmission. The signal is modulated using 8 level vestigial sideband modulation (8-VSB) and transmitted.
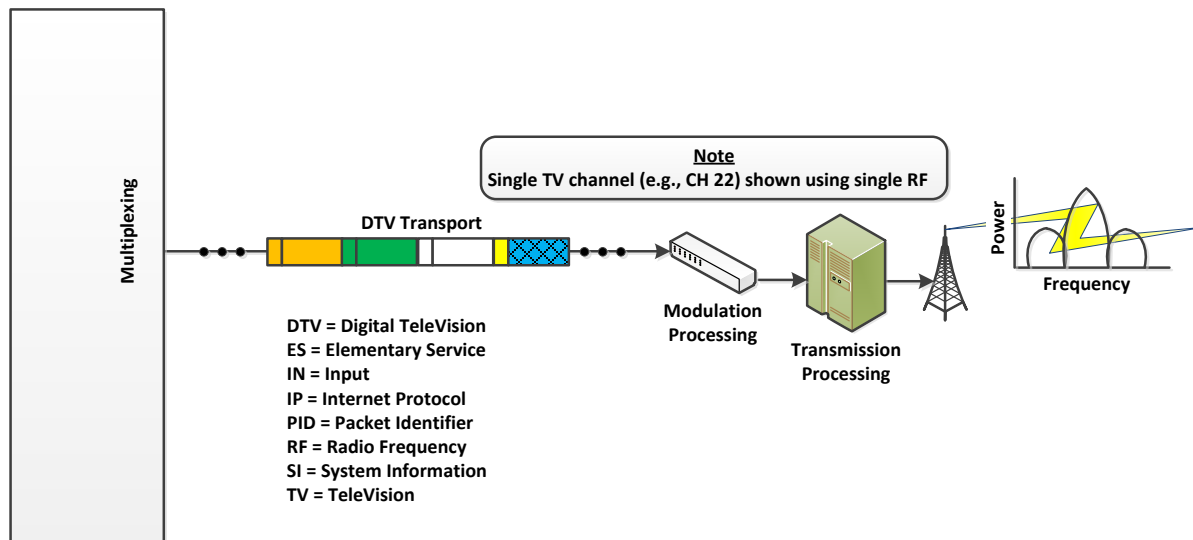
Figure 23: Transmission of Multiplexed Data.

Datacasting Reception and Processing

Datacasting reception (see Figure 24) begins with reception of the signal by a receiver connected to a computing device, not a television set. The receiver can be a USB "dongle," or Linux based appliance. Any UHF or VHF antenna will capture the signal. However, only devices with the required software, decryption and registration will actually be able to convert the signal into useful information. Upon receipt of a signal, the datacasting system demodulates the signal and identifies the packets directed to the device according to the assigned PIDs. A device can be designated as the unique registered recipient or as part of a group registration.

When a device is authorized to receive data, the encrypted IP packets are decrypted for processing by the appropriate application software in the device. Figure 25 depicts the process.
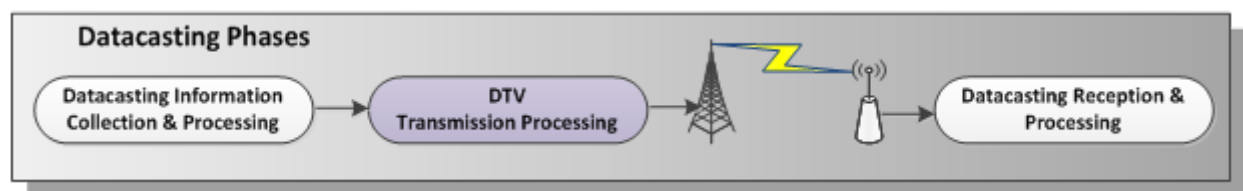
Figure 24: Datacasting Reception and Processing.

Figure 25: Datacasting Receipt.
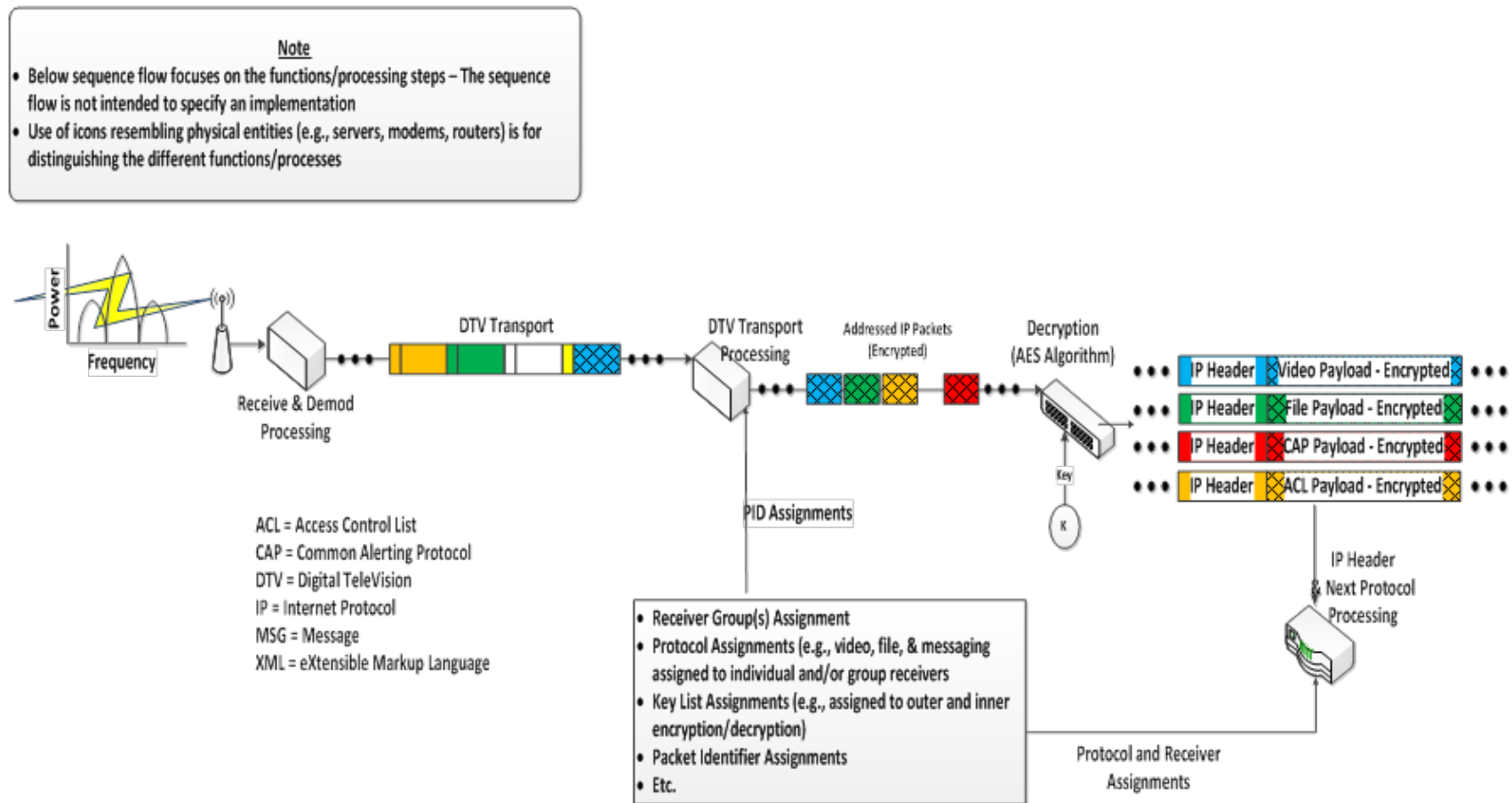
Finally, IP packets are processed according to type (streamed data, files, messages and access control) as shown in Figure 26. The further processing of data type is contingent on the access control list that identifies the encryption keys and receiver assignments to be used for each data type processed by this receiver.
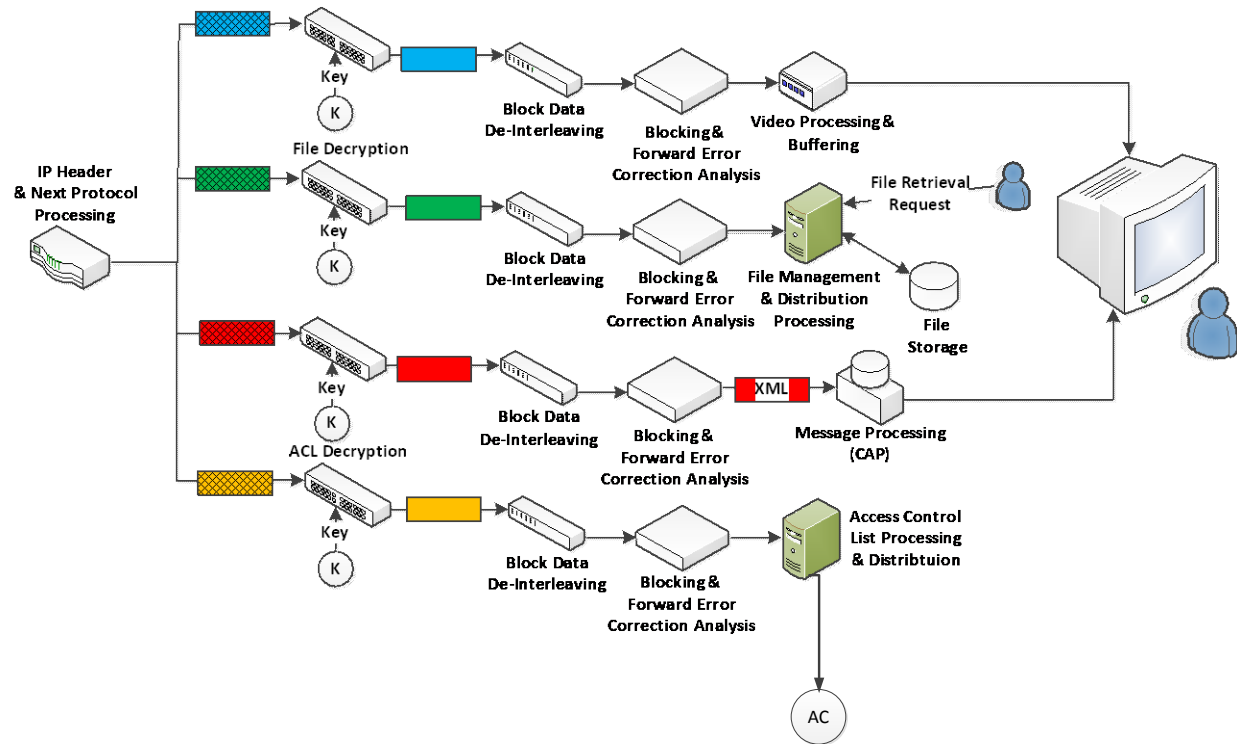

Figure 26: Processing Received Datacasting Information.

7 APPENDIX B: Test Plan for the City of Chicago Datacasting Demonstration

The following test plan was distributed to participants in advance of the test. These procedures had to be significantly modified due to personnel commitments of the CPD and CFD.

Test Objectives:

The demonstration has the following objectives:

(1) The primary objective is to demonstrate the technical capabilities of datacasting, especially its ability to provide communications coverage over water (in this case, Lake Michigan).

(2) The secondary objective is to demonstrate that datacasting has utility to emergency management.

(3) Detailed test objectives include the following:

    a. Demonstrate the ability to reliably broadcast large files containing data useful to first responders via datacasting;

    b. Demonstrate the ability to stream real-time video to multiple users via datacasting; and

    c. Demonstrate the ability to simultaneously broadcast data to multiple agencies using datacasting technology (i.e., to demonstrate the potential for datacasting to increase interagency coordination during emergencies).

Test Location:

The test will be conducted on the Chicago shore of Lake Michigan, particularly along the Lakefront Trail from near North Avenue Beach south toward DuSable Harbor. In developing the scenario, test designers at the JHU/APL tried to strike a balance between operational realism, technical significance and costs. A scenario staged on Lake Michigan, such as police or fire boats responding to a boat on the lake in distress, would have the most operational validity because it most closely approximates the operational stresses encountered by first responders in boats. However, having the scenario in the middle of the lake adds nothing to the technical validity of the test, might be difficult to execute and could potentially be costly (to simulate a boat on the water and to capture images of that boat).

For this reason, a scenario was developed consisting of a relatively low-cost, easily executed set of procedures along the waterfront combined with a potentially more expensive, harder to execute set of procedures offshore in Lake Michigan.

Specific actions at each location include:

(1) A simulated "incident" occurs in the area around Castaways Restaurant near North Avenue Beach. A simulated "suspect" is tracked by Chicago Police Department (CPD) surveillance cameras.

(2) Data and video will be selected for transmission and designated for datacasting by CPD officers. Officers performing this operation will be designated by the CPD.

(3) Actual datacasting broadcasts will occur at the offices of WTTW.

(4) Locations of persons/organizations receiving datacast messages are TBD.

Technically, they could be positioned anywhere within the WTTW broadcast volume. It is expected that one receiver will be installed in a CPD vehicle and one will be installed inside a fire or police boat.

Participants/Responsibilities:

The following organizations will participate in the demonstration and will have the following responsibilities:

(1) Department of Homeland Security (DHS) Science and Technology (S&T) Directorate Office for Interoperability and Compatibility (OIC), First Responders Group (FRG): DHS S&T is the authority for this demonstration.

(2) Chicago Police Department (CPD):

    a. CPD will provide access to enable the test team to integrate a capability to enable data transmission from CPD to the local Public Broadcasting System (PBS) affiliate, WTTW, for broadcast via datacasting.

    b. CPD will provide a video feed/dispatch operator to identify and "push" video and data from the CPD to the datacasting system.

    c. CPD will provide/arrange assets to receive data broadcast via datacasting. Currently, it is planned that a datacasting receiving capability will be integrated into one police vehicle and one boat, and that these assets will be deployed to observe the on-going exercise.

(3) United States Coast Guard (USCG): The USCG station in Chicago will participate in the demonstration as a receiver location on one of their boats. They will provide access to the test team in order to supply a properly configured laptop to receive the datacasting signal. The boat will be deployed in order to observe the ongoing exercise.

(4) WTTW will host the technical aspects of the demonstration. As host, WTTW will provide the following support:

    a. Broadcast infrastructure: WTTW will provide access to a portion of its broadcast signal for the purpose of transmitting encoded datacast data in support of the demonstration and prior to the demonstration to enable

testing of the architecture. It will also provide physical access to its broadcast equipment to SpectraRep for the purpose of installing datacasting equipment necessary to integrate WTTW broadcast equipment with CPD Office of Emergency Management and Communications (OEMC). Representatives of WTTW will work with SpectraRep to define the integration requirements for the demonstration.

(5) <u>Johns Hopkins University Applied Physics Laboratory (JHU/APL):</u> JHU/APL is DHS S&T's technical authority for this test. Its responsibilities include:

   a. Test Design: JHU/APL will coordinate stakeholders in designing of a test that meets the objectives of the stakeholders. JHU/APL will develop required test plans and procedures.
   b. Test Preparation: JHU/APL has sub-contracted SpectraRep to provide and install required test equipment; JHU/APL has responsibility for overseeing SpectraRep during this process.
   c. Test Execution: Although the test will be executed by representatives of CPD, JHU/APL is responsible for ensuring that participants understand their roles and can perform them.
   d. Test Analysis: JHU/APL is responsible for test analysis.

(6) SpectraRep: SpectraRep is under contract to JHU/APL to support demonstration of the datacasting system in Chicago. This task includes:

   a. Planning – SpectraRep will support planning of the event in Chicago. This includes working with CPD and WTTW to develop integration requirements for the test.
   b. Provision of equipment – SpectraRep will provide the necessary equipment to enable datacast information to be transmitted from WTTW and to be received by test participants.
   c. Installation – SpectraRep will install and integrate the equipment in Chicago.
   d. Maintenance – SpectraRep will be responsible for maintenance to ensure that the datacasting system equipment is functional throughout the demonstration.

Dates/Duration:

The test is currently scheduled to occur on August 12-13, 2015. This demonstration is expected to last no longer than the afternoons of each day. The actual test can be completed in approximately one hour; however, two days have been allocated to accommodate the USCG availability (on August 12) and CPD availability (on August 13). Full days are assigned to execute dry run and other pre-tests of equipment. Time has also been allotted to run the test a second time if desired.

Test Preparation:

Preparation for this demonstration consists of the following steps:

(1) Test Planning: Test planning has been conducted as a series of meetings (most performed via teleconference) since April 2015.

(2) System Integration: Equipment for transmission was installed at WTTW during June 2015. A demonstration of the capability (not in an operational environment) was executed the week of June 22.

(3) Test Procedures: Draft test procedures were developed and disseminated for review by stakeholders during the week of August 3.

(4) Test Equipment: Equipment for reception of datacasting data was mailed to test participants during the week of August 3.

(5) Equipment Checkout: Members of the test team from JHU/APL and SpectraRep will arrive in Chicago on the morning of Wednesday August 12 to perform final tests on the equipment to be used during the test.

Set-up Procedures:

The following represents a sequential description of the steps required for system checkout on August 12. The times are approximate and will be modified to accommodate public safety officer duties:

(1) 0500 – 1100: Technical representatives from JHU/APL will travel from the Washington, DC – Baltimore, MD area to Chicago, Illinois, in order to perform a system checkout prior to the August 13 demonstration of a pilot datacasting system.

(2) 1100 – 1500 (approximate): General test of datacasting system is performed as follows.

 a. Verification that data and video can be transmitted via the datacasting configuration. Test messages and videos will be "pushed" to the datacasting system and a target broadcast will be executed. The target of broadcast will be a control laptop operated by SpectraRep.

 b. Verification that fictional data prepared for the test is loaded and ready for the test. Fictional/non-sensitive data is used to exercise technical and operational capabilities without risking compromise of protected information. Possible data include the following:

  i. PDF map of the Chicago Lakefront and Lake Michigan;

  ii. PDF map of DuSable Harbor pier area;

  iii. Pre-recorded MPEG audio file simulating a 911 call describing a potential mugging or sexual assault on the Lakefront Trail;

  iv. Suspect image; and

        v.   Fictional "suspect" criminal/arrest/warrant record.

   c. Checkout of receivers: A teleconference line will be established. Representatives of the CPD with receivers are encouraged to call the test team during this window, and the test team will push test material. Receipt of the material will represent a successful system check. The objective is to perform a test of every receiver distributed and to correct any problems encountered.

(3) 1500 – 1700: Exercise Dry Run: A representative of the test team will walk the test course along the Lakefront Trail. CPD will ensure that the representative can be observed using CPD surveillance cameras along the entire length of the course, and to identify which cameras will need to be streamed. Performing a dry run is very beneficial because it helps ensure exercise execution. Without a dry run, the inability to correctly execute test procedures is a major cause of test failure and a significant source of test expense.

(4) 1700 – 1800: Checkout Review Meeting: SpectraRep and JHU/APL will meet to assess the results of checkout and additional efforts required (if any).

Test summary:

The demonstration of the datacasting system in Chicago is intended to simulate the data dissemination capabilities of the system in the case of an incident along the lakeshore or over water involving marine assets. Because of uncertainty in the availability of boats (both as a host for receiving equipment, but also as a target to be tracked), two separate scenarios have been woven together. The first scenario, which will be executed near North Avenue Beach in full view of CPD police cameras, simulates a "suspect" fleeing from an assault. In this scenario, an assailant is interrupted during an assault by a passerby. The assailant flees southward along the trail, while the passerby calls 9-1-1 to report the incident. Video operators detect the fleeing "suspect" and disseminate video of the suspect.

For the demonstration, one to two test support staff, dressed in clothing that makes them readily discernable from other persons in and around the test location but without causing alarm, will play the part of the "suspect" (and also likely act as test conductor). Prior to the test, they will deploy at a point near Castaways Restaurant in view of a CPD surveillance camera and await the beginning of the test. When all participants report that they are in place and ready, an operator in the CPD communications center will initiate an incident and issue an alert with data using the datacasting system. The operator will then begin streaming video of the "suspect." At this point, the "suspect" will be told to begin walking south along the Lakefront Trail, and stopping periodically to ensure that he/she remains in view of the surveillance camera.

In the second part of the scenario, pursuit of the fleeing "suspect" is interrupted by an urgent call from a boat in Lake Michigan. Approximately a mile from the shore, someone has fallen overboard in this scenario. Boats responding to the incident use video shorefront cameras to understand the unfolding situation in order to execute a rescue. This second

part of the scenario is, in fact, more in line with the expressed desires of CPD; they envision datacasting as a valuable resource to aid in search and rescue operations in Lake Michigan. However, provision of a boat and capture of video - which might require use of an airborne asset - were deemed potentially too expensive. For this reason, the first scenario on the shore was appended to this scenario to ensure that a robust technical demonstration in an operational environment could be executed, even if the full operational capability could not be demonstrated during this exercise.

To simulate the waterborne portions of the scenario, a video of a boat would be needed. Currently, the plan is to use the cameras on the shore from Division Street to Schiller Street (there are four cameras in these five blocks) to view both a "suspect" walking along the Lakefront Trail and a boat or boats in Lake Michigan. If there is a police boat available, the test team will attempt to track it; if not, then "targets of opportunity" (i.e., other boats in the lake) will be tracked as available. Video will be transmitted via datacasting to the police boats.

Detailed procedures are contained in the following paragraphs. An exercise start time of 1200 has been set; this can be moved at the convenience of CPD.

Test Procedures:

On August 13, 2015, the full test scenario will be exercised with the CPD. The following test procedures will be executed in the sequence described below:

(1) 0900 – 1000: Pilot Demonstration Readiness Review. Representatives of the test team, key stakeholders and test participants will meet to review readiness to proceed. JHU/APL and SpectraRep will present the results of the equipment checkout. The review will be held at the OEMC.

(2) 1030 – 1430: A teleconference line will be set up to enable participants with receivers to contact the core test team. Although the fully live demonstration is scheduled for noon, participants with receivers may request data at any time of the day. This open line helps achieve two objectives: (1) mitigates the risk of a police officer needing to respond to a real-life incident coincident with the test; and (2) provides opportunities for participants to make multiple requests from different locations thus increasing the sample size.

(3) 1030 – 1200: Participants with datacasting receivers will deploy to the locations identified by their respective organizations. A critical objective of the exercise is to demonstrate datacasting coverage even into areas where coverage with other communications technologies is limited. Organizations are encouraged to deploy receivers to locations of interest to them. There is no implication intended that police officers would be supporting the demonstration for ninety minutes. However, the implication is that the core test team will be able to "push" data ninety minutes prior to the live exercise.

(4) 1145 – 1200: Test participants with receivers will inform the core test team that they are deployed and ready to support the test. Ideally, this would be done via the

open teleconference line set up for this purpose. Note: it is understood that the availability of operational personnel cannot be guaranteed for the duration of every part of the test.

(5) 1145 – 1200: Test participants simulating "assailants" fleeing along the Lakefront Trail take their positions near Castaways Restaurant at North Avenue Beach.

(6) 1200: An operator in the CPD OEMC detects the "suspects" on video and creates a new incident using the datacasting system.

a. OEMC operator activates datacasting capability.
b. OEMC operator creates an incident entitled "Demo: Lakefront and marine." Duration is set to 24 hours to enable test engineers to retrieve data from laptops after the incident.
c. OEMC operator inputs a text message: "Test: Assault at North Avenue Beach, suspect fleeing."
d. OEMC operator selects the receivers designated for participation in the test to receive the datacast transmission.
e. OEMC appends additional pre-selected data to the incident

(7) 1200 – 1205: OEMC operator begins streaming real-time video of "suspects."

(8) 1200 -- 1210: Participating officers with receivers confirm receipt of the datacasting data.

(9) 1200 – 1210: OEMC operator reports confirmation that units are receiving video. The test conductor on Lakefront Trail starts exercise. Both "suspects" begin walking south along the Lakefront trail. As they are walking, test conductor periodically confirms that both "suspects" are within view of a surveillance camera.

(10)   1230: When the "suspects" arrive at East Schiller Street, the second phase can begin.

(11)   1230: An operator at OEMC creates a second incident entitled: Man Overboard Test.

f. OEMC operator enters text: "TEST: Man overboard in Lake Michigan south of North Avenue Beach.
g. OEMC operators designates test participants for targeted broadcast.
h. OEMC operator appends image of boat.
i. OEMC operator appends information about the boat.
j. OEMC operator appends maps.

(12)   1230: The operator at OEMC begins streaming video of a police boat on Lake Michigan (if available) or of a randomly selected boat on the Lake. Cameras on the shorefront located at Schiller Street, Banks Street, Goethe Street and North of Division Street are capable of providing video of activity on the lake.

Measurements:

The following data collection will be performed:

(1) At the completion of the test, JHU/APL and SpectraRep will collect the laptops and dongles, and verify the receipt of all messages transmitted on each laptop.

(2) Members of JHU/APL will query officers participating in the test regarding the utility of the information provided, as well as their ability to follow the events simulated in the exercise using just the datacast information.

Post-Test:

JHU/APL will perform post-test analysis and develop a final report documenting the results of this test.