Technical System Overview

Robby Hill

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INTRODUCTION

Provide an overview of the entire Mutualink system from a technical perspective and a high level understanding of the relationship between the various components of the system.

INTENDED AUDIENCE

Not for end-users.

Intended for anyone required to understand the technical underpinnings of the Mutualink system such as:

- Support Engineers,
- Field Engineers
- VARs/OEMs
- Those responsible for installing systems and supporting end users

REQUIREMENTS

This document assumes that readers are fairly proficient in general computer skills and have a good understanding of IP networks.

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OVERVIEW

Mutualink is an IP-based, multimedia communication resource sharing platform that allows agencies and critical community assets to communicate and inter-operate in a secure environment.

PRODUCT GOALS

Primary goal of the Mutualink product is to allow disparate organizations throughout a community to quickly communicate and share information. Specifically:

- Allow organizations to maintain complete and exclusive control over their resources and information
- Communication should not be open to eavesdropping by unintended parties.
- Support ad hoc situations and not depend on any common servers or switches to accomplish this communication.
- Communication should include voice, video, instant messaging, and file sharing.
- Support a universal “any-to-any” function for devices supporting the same media type regardless of device type, manufacturer, capabilities, etc.
- Simple and intuitive for an end-user to operate.

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KEY SYSTEM ATTRIBUTES

A fully-distributed peer-to-peer system

A fundamental attribute of the Mutualink system that it addresses the primary goal of organizations maintaining complete control over their communication at all times. No central server or switch to own, control or administer

Standard IP networks used to interconnect components of the system

Allows the system to be deployed on most existing networks without geographic limitation. Allows IP to be used as the "common denominator" media format between all end devices.

All communications are authenticated and encrypted

The authentication and encryption process allows each organization to ensure that they are talking to the correct peer organization. Communications are private, preventing identity spoofing and eavesdropping.

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SYSTEM COMPONENTS

Endpoints (EP)

- Primary component of the Mutualink system
- Stand-alone devices connect to each other (and the rest of the Mutualink system) solely by the IP network
- There are two fundamental types of EPs in the current system

Network Interface Controllers (NIC)

- Standalone embedded device that acts as a gateway between the Mutualink system and any external system
- Provides and/or receives such media under the direction of one or more authorized IWSs.

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NETWORK INTERFACE CONTROLLERS

There are several flavors of NICs depending on the type of external system it is interfacing to:

- **Radio NIC (R-NIC) -** Contains radio interface hardware (RIB) to connect to various 2-way radio systems. Connects directly to portable, mobile, or fixed radios, or it may connect indirectly through radio equipment such as consoles or remote interfaces. The R-NIC is an audio-only device.
- **Video NIC (V-NIC) -** Sends and receives video to/from an external video system; this video may either be in analog (composite/s-video) or digital (IP-Video) format. Contains analog video capture hardware so that it may digitize analog video signals from external video systems to distribute via Mutualink.
- **Telephony NIC (T-NIC) -** Interfaces to external telephony systems such as the PSTN, a circuit-switched PBX, or a Voice-over-Ip (VoIP) phone system. The T-NIC contains either FXO or FXS telephony hardware.
- **Generic IP NIC (IP-NIC) -** General-purpose NIC that may perform an IP function that does not require additional hardware. For example, Voice-over-IP or IP-Video systems. IP-NICs may be re-purposed as required in the field.

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INTEROPERABILITY WORKSTATIONS (IWS)

A computer running Mutualink software (GUI) that an operator uses to communicate with other organizations.

- A custom-manufactured desktop or laptop computer running a security-enhanced version of the Linux operating system (typically a CentOS or Fedora distribution).
- May include custom audio accessories such as speakers, microphone, headset, etc.
- The IWS allows the operator to perform two major functions:
  - Act as an individual communications device. Used to send and receive voice and video transmissions, instant messages, and files with other organizations.
  - Direct the operation of any NICs that it is authorized to control. Controls the information flow through the NICs over IP connection. If the NICs are gateways, then the IWS is the controller that opens and closes those gates.

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IP NETWORK

All EPs are connected to each other and the rest of the system by an IP network. The IP network is a key element of the entire system and is the only real “common component.

INTERCONNECT NETWORK REQUIREMENTS

- Must be an IPv4 routable network. A routable network means that each component on the network must be able to route (communicate) directly with every other component. Note that this requirement disallows any Network Address Translator (NAT) devices between components.
- Must be enabled for multicast. The Mutualink system uses multicast wherever possible to utilize bandwidth most effectively. The EPs use IGMP V3 to control their multicast group memberships.
- Should have Quality-of-Service (QoS) enabled. This will ensure that the highest priority traffic gets through if network congestion is encountered.

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PRIVATE INTERCONNECT NETWORK

- The interconnect network is typically built out as an encrypted VPN (Virtual Private Network).
- A secure VPN router is located at each location to be included in the VPN and secure tunnels are built between the routers (the possible VPN topologies are many and are beyond the scope of this document).
- Advantage of the VPN approach is that it creates a local “walled garden” network for the Mutualink EPs at each location.
- Keeps the EPs and associated inter-organization traffic segregated from the organization's LAN.

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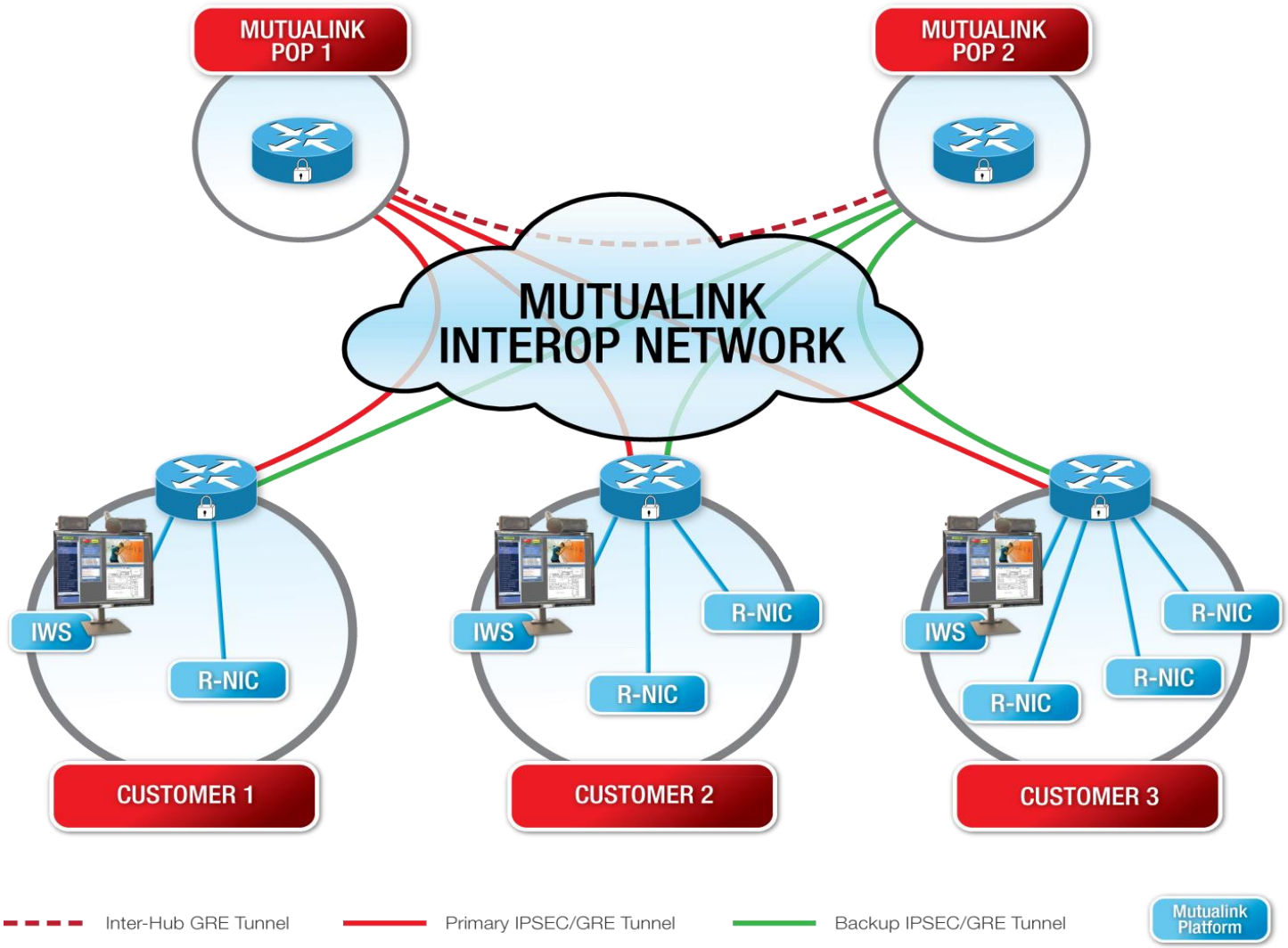

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ADMINISTRATIVE SERVICES / IDENTITY AUTHENTICATION SERVICE

- A standard Public/Private Key mechanism is used to validate identity of an EP. An EP keeps its Private key and shares its Public key. Any EP that has another EP's public key can a) verify that data originated from that specific EP, and b) send it encrypted data decodable only by that EP.
- The Key Distribution Service (KDS) is used to securely distribute public keys. EPs send their public key to a KDS for authentication.
- Once the identity has been verified, the EP's public key is then made available by the KDS to all EPs on the network.
- Only EPs that have had their identity authenticated may create or participate in secure incidents. All authenticated EP's display a padlock next to its name indicating it has received its public key from the KDS.
- Note that once all public keys have been distributed to all EPs, the KDS is not required; only when a new EP is added to the system or an EP changes its identity does the KDS come into the picture.

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NETWORK MONITORING SERIVCE (NMS)

The Mutualink Network Monitoring Service (NMS) monitors enabled EPs

- Determining how the system is performing and if any problems exist.
- When an EP is enabled for NMS, it periodically sends a “heartbeat” message to the NMS to tell the NMS it's still alive & connected; if the NMS doesn't receive a heartbeat from an EP for a certain period of time, it will raise a “EP Connection Lost” alarm.
- Additionally, if the EP detects any internal inconsistencies (with software, hardware, or the environment) it will send those alarms to the NMS in the heartbeat message.
- The NMS can send alert emails to support personnel upon the detection of any of these alarm conditions.

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SYSTEM OPERATION / AUTO DISCOVERY

- An EP periodically announces its presence on a configured multicast address.
- It also monitors this multicast address for announcements from other EPs and will automatically discover the presence of any EPs configured on that same multicast address.
- All such EPs effectively form a single Mutualink “system” of ad hoc peers, so this multicast address is known as the System Multicast Address.
- It is possible for many Mutualink systems to coexist on the same interconnect network, but EPs will only be able to communicate with EPs that have the same System Multicast Address.

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INCIDENTS AND PATCHES

- An incident is the basic “container” of communications on the Mutualink system;
- All communications and information sharing occurs within the context of an incident.
- IWS operator can create a new incident and invite other organizations and/or resources into that incident.
- An incident is comprised of one or more “patches”.
- A patch is a shared media stream that utilizes a single unique multicast address to transfer media between members of the patch.
- An incident is first created, two audio patches are usually created: The Intercom patch and the TX patch. The Intercom patch is between IWSs only.
- If a V-NIC joins the incident to provide a video feed, a video patch is then created as well. Members of an incident may join any of the patches within the incident as desired.
- When a secure incident is first created, the initiating EP will dynamically generate a symmetric encryption key (nominally AES-256) to be used for all communications within that incident.

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INCIDENT INVITATIONS

- To invite another EP to a incident, the IWS or NIC Resource is drag and dropped into the incident.
- This will trigger an invitation to be sent to the desired EP(s). These invitations are sent using the standard SIP protocol and contain a list of all the patches in the incident as well as the incident encryption key for secure incidents.
- The incident key is first encrypted with the recipient's public key before being included in the invitation.
- Only the intended recipient may then decrypt this incident key (with their private key) which maintains the integrity of the incident key.
- Only EPs appearing secure to the inviting EP may be invited to a secure incident.

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MUTUALINK CONTROL CHANNEL (MCC)

The MCC is a proprietary protocol used to communicate status information between Mutualink EPs.

The MCC is a one-way unicast or multicast protocol on port 5001 and is used in two ways:

- MCC is the protocol used on the System Multicast Address to announce the presence of an EP, and it's status.
- MCC is also used on the multicast address of each patch to notify other patch/incident members which other EPs are in the patch.

A secondary purpose of the MCC messages on the System Multicast Address is to coordinate the use of multicast address pools.

Each periodic announcement sent by an EP lists all the multicast addresses that are in use by incidents it is a member of.

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