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White Paper

System Overview of NTS-7

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What is NTS ?

NTS, or "Network Telephony Services", is a communication system for telephone lines, computer networks, and the Internet. NTS has many features for combined text, video, and voice communications. NTS is a "multi-media telephone system" that supports many kinds of text, video, and voice calls and messages between telephones, computers, browsers, the TTY devices used by the deaf, wireless devices, email, Message Boards, H.323 video devices, and so on. NTS's "anything to anything" architecture creates communications using "gateways".

NTS uses an embedded scripting language. NTS scripts can be created using a "drag and drop" graphical tool, or can be written by a programmer. NXi scripts are used to define and modify system operation, and can also create their own graphical forms. NTS can be customized in very flexible ways to meet requirements.

NTS's gateways allow integration with remote databases, a wide variety of communication devices, and remote systems.

What's New in NTS-7?

The most important change in NTS-7, compared with the earlier NTS-6.4, is a completely new video system. The video in NTS-7 has the following features:

-- Superb quality with state-of-the-art H.264 (and H.263) codecs
-- True "single port" operation where only a single "outbound" network port is required across firewalls.
-- Compatibility with standard H.323 video devices
-- A single inbound IP address for H.323 video calls can be routed to any NTS group.
-- Video calls in NTS-7 are "phone like" in operation with support for group rings, call transfers, and mail services for unanswered calls.
-- Support for 2-party, and multi-party, video calls (up to 10 participants)
-- Audio is part of the video stream. This means people's lips move in synch with the video image.

In addition to video support, NTS-7 has much improved support for System Activity reporting, also called "Call Data Reporting (CDR)". New CDR events are easily added in the new "Call Data Event Editor" admin utility, and any CDR event may be fired under script control.

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Other enchancements in NTS-7 include:

- Text-to-Speech Service
  - The NTS-7 T/S Service may be used under script control, and is useful in many situations. For example, the Notifications and Alerts product uses Text-to-Speech to deliver a typed message to voice phones.
- Curl Service
  - The NTS-7 Curl Service is also usable from scripts. This service makes any content on web sites or ftp sites accessible and usable by NTS.
- Asterisk Gateway
  - “Asterisk” is a popular open-source phone system platform. The new NTS-7 Asterisk Gateway supports close integration with these phone systems.
- Conferencing Service
  - NTS-7 has extensive support for video, audio, and text “virtual meetings”. A participant can join an NTS-7 virtual meeting by any mix of these media types, so a phone-only participant, or a text only participant, can take part in the same conference call as a full video, audio, and text participant. The new NTS-7 Conferencing Service replaces the earlier NTS-6 text-only Chat Room Service to manage these more complex conference types.

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A2. The NTS architecture

NTS version 6 is a modular client-server architecture for data networks such as LANs, WANs, and the Internet. NTS 7 is a distributed and scalable architecture where additional NTS servers automatically load balance, support redundancy and fail over, and support higher numbers of users.

NTS "services" are separate programs or processes, and each NTS service talks to other NTS services by TCP or UDP data packets.

NTS services are of two basic types:

- NTS gateways
  - NTS gateways connect NTS to something "foreign". For example, the NTS Telephony Server connects NTS to analog telephone lines or T1/E1 digital telephone trunks. The "SIP Telephony Server" connects NTS to VoIP (Voice over IP) telephone connections, while the NTS Internet Gateway connects NTS to browsers. The SMTP Gateway sends and receives email, and the SQL ServicesGateway links NTS to databases. The NTS client software, called NexTalk, is not an NTS service and also needs a gateway. The RPS (Remote Proxy Service) is the gateway used by the NTS client software.
- NTS services
  - NTS has multiple "services" for internal purposes. An NTS service is a program or process that communicates by TCP or UDP data packets with other NTS services. All NTS services are launched and managed by the NTS "Process Manager" (PM).

  Some examples of NTS services follow. The important NTS "Call Service" manages NTS conference calls while the "Call Flow Processor" supports NTS scripts. The "Locator Service" handles NTS logins, and the LS is then used to let one NTS service or client find another. The NTS "Data Services" supports database access. The NTS "Message Notification Service" handles messaging and IM's. See Section B for a listing of all NTS services.

Any NTS service or module can communicate with any other NTS module. It should be noted that all the NTS services can run on the same computer, or NTS services can be run on many computers separated by thousands of miles across a wide area network (WAN) or the Internet. One, or many, instances of any NTS service can be active in a single NTS system, and there is automatic redundancy and fail-over between instances of a particular NTS service.

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The NTS client-server architecture also has a client-side program called "NexTalk". A few notes on the NTS client software follow.

The NTS client software is itself modular. Different client-side functions are separated into separate code modules which are each a "DLL" launched by the core client program. Examples of NTS client modules include (a) the Phone Book, (b) the Viewer, (c) the split-screen text chat form, (d) Instant Messaging, (e) Video conferencing, (f) the Relay Call module, (g) the Notifications module, and so on. In addition to these "user level" modules, there are also administrative modules available, such as the (h) "Users & Groups" admin module, (i) Telephony Services admin module, (j) the script creation utility, (k) One-Nbr settings module, and so on. There are also system monitoring modules available from the client software program, including the (l) Logins Monitor, (m) Call Monitor, and (n) the Ports Monitor.

A given NTS user might be allowed to run certain NTS client modules, but not others. NTS allows control of the privilege level a given NTS user has in the system, for example, a normal NTS end-user would not be allowed to see or run the administrative or system monitoring modules. A full NTS system administrator will be allowed complete access to the NTS system, while a "Supervisor" class user might be allowed to see and run some, but not all, admin and monitoring modules. See Section B4 for details on how NTS manages the privilege level of users.

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A3. Example NTS Calls

A key NTS service is the NTS "Call Service" or "CS". The Call Service creates conference calls, or "bridges", with any number of participants. All NTS calls are conference bridges, and NTS uses CS calls even to deliver messages and notifications. Another important NTS service is the "Call Flow Processor" (CFP) since the CFP is the service that runs NTS scripts.

At a high level, NTS is best understood with two key concepts: (a) all NTS calls are conference bridges, and (b) an NTS script, running in the CFP, can be a call participant. Allowing a script to be a call participant gives NTS much of its power and flexibility.

A simple example of an NTS call will be useful. Suppose a communication device "A" wants to call the communication device "B" within NTS.

In practice, all NTS calls follow the same pattern. The calling side "A" within NTS will do the following:

1. Gather up needed calling information, such as information on how to reach the destination "B".
2. Connect to an NTS Call Service (CS).
3. Request that the CS create a new call conference (also called a "call bridge" or "call object")
4. Now, request that the CS create a new outdial call leg to the Call Flow Processor (CFP), and request that the CFP activate a desired NTS system script.
5. Pass across calling information to the NTS system script.
6. Let the NTS system script do its job to complete the call.

The steps above are shown in the figure below. Notice that the generic communication devices A and B are shown linking to generic gateways "GW1" and "GW2". NTS uses gateways to convert the signaling needs of "foreign" communications devices to the native or internal data streams used within NTS.

*****

Figure: Generic Example of an NTS Call

A more concrete example will also be useful. Suppose the calling side "A" above is the NTS client software "NexTalk", and the called-side device is a telephone. The NexTalk software enters the NTS architecture via the "RPS" gateway, while the phone enters the NTS architecture via a "Telephony Server" gateway. The RPS gateway creates a "VPN tunnel" on a single TCP port to a NTS client program.

The steps above will now look at follows.

1. Calling side A gathers up needed calling information. In this case, the calling information will include (a) the phone number of the telephone "B", (b) the desired caller-ID phone number for this outdial call,

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(c) the type of phone call (voice phone or text phone), and so on.

2. The client A, via the RPS gateway, connects to an NTS Call Service (CS).
3. A sends the CS a request to create a new call conference.
4. "A" requests that the CS create a new outdial call leg to the Call Flow Processor (CFP), and also request that the CFP activate a desired NTS system script. In this example, the correct NTS script will be the "csdial" system script designed for phone calls.
5. "A" passes across calling information to the "csdial" NTS system script.

6. Let the NTS system script do its job to complete the call. In the current example, the "csdial" system script has quite a lot of work to do. It will (a) consult with the NTS "Device Services" service to find an available Telephony Server port or channel, (b) communicate with the selected Telephony Server to set up the telephone call, (c) command the Call Service to create an outdial call leg to the selected Telephony Server with the needed calling information. Once the telephony call is created, then the NTS system scripts will control things like detecting whether a hearing person, or a text device, has answered the telephony call and dynamically flip operation between voice and text. If side "B" is a text telephone, then the system script will configure the Call Service call object to send text characters between side "A" and "B".

The steps above are shown in the figure below.

Figure: An Example NTS Telephony Call

Some NTS calls become more complex. The NTS "Placeholder Call" script, for example, creates five or more call legs from a single Call Service call.

The use of system scripts within NTS accomplishes several things.

- -- System scripts shield the calling, and called, parties in a call from complexity.
  - -- The calling side in a NTS call simply calls the appropriate system scripts, passes across its information about a call, and lets the system script handle the details.
- -- System scripts allow customization of NTS behavior and operation.
  - -- System scripts can be easily edited and changed. This means that NTS operation can be easily customized to meet requirements. Entirely new NTS system behaviors are often possible by passing control of a call to a new and innovative script.

B. Descriptions of NTS services

Each service in the NTS-7 architecture will be briefly discussed below.

B1. Basic NTS services for system operation

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B1a. Data Services (DS)

NTS depends on access to its own system database, so the DS is a key service in the NTS system. The NTS DS can link to and use a variety of standard databases, as listed below:

-- Free (no cost) databases supported: Oracle Express, mySQL, and Microsoft's MSDE 2000 database engine.

-- Other databases supported: Oracle and Microsoft's SQL Server.

Please note: Earlier versions of NTS have supported Microsoft's Access database; however, NTS-7 uses multi-threaded database access from multiple NTS services, and NTS-7 is not well served with a file-based database product like Access. MS Access is not recommended for NTS-7 installations.

NTS 7 allows multiple Data Services instances to be run on multiple computers, and NTS handles load balancing and redundancy between these instances. See section E1e. "Scalability and redundancy and the NTS database" for a discussion of this issue.

B1b. Locator Service (LS)

It was mentioned above that any NTS service or module can find any other NTS service or module. How is this done ? The Locator Service (LS) is used.

When an NTS service starts up, it has to "log into" and register with the NTS system.

If the NTS service login is allowed, then the Locator Service will write an entry into "Session Table" in the NTS system database, as well as write this event to the Login Channel in the Channel Service as discussed below. The Locator Service will then return a "Session Cookie" back to the NTS service or client logging in. The service must periodically renew this Session Cookie, or the NTS system will terminate the service's logged in status.

The NTS Locator Services keep track of all NTS services, and any NTS service can find any other NTS service by placing a destination request to a Locator Service.

B1c. Channel Service (Ch.S)

The NTS Channel Service provides a way of synchronizing information

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throughout an NTS system. This NTS service provides “channels” each of which support “one to many”, “many to many”, and “many to one” communications. An NTS channel can be thought of like a TV or radio channel where anyone listening on this channel will receive the same information. In order to specify which channel you want to listen to, you choose a channel name. Each Channel Service supports the same named channels as every other instance of the Channel Service, and each Channel Service sets up a TCP/IP connection with every other instance of this NTS service. If data is sent on a given channel in one Channel Service, then this Channel Service will send this data to the identical channel on every other Channel Service in the NTS system. So, if a NTS service is “listening” on a given channel name, it will see data sent by any channel-sender, anywhere in the NTS system, as long as this data was sent onto the same Channel name.

One example of a NTS channel is the Login Channel mentioned above. On each NTS login, or logout, an event is sent to the Login Channel by a Locator Service on a particular Channel Service. Any NTS service, including other Locator Services, listening on this channel on any Channel Service will see a stream of login and logout events for the entire NTS system.

B1d. Call Service (CS)

The Locator Service, Channel Service, and Data Services described above allow NTS services to find other NTS services, synchronize information, and store/retrieve information to the system database. Another important NTS service is the “Call Service” (CS). The Call Service manages calls within an NTS system, so an NTS client calling to or from another client, a TTY, a browser, and so on, are all calls managed by the Call Service.

Every call made in the NTS system is a “multi-media conference bridge”.

The way to think about a NTS call being a “conference bridge” is to consider what a regular telephone conference bridge is like. Most people have used telephone conference bridges where someone will tell you “I have set up a telephone conference bridge... dial this 800 number and enter the passcode 2345". In most telephone systems a conference bridge can exist even if no one has yet joined it. It has a unique identifying number and perhaps a separate password. Everyone who joins a telephone conference bridge can hear, and talk, with everyone else on this same bridge.

Every NTS call is a “conference bridge”. Each NTS call has a unique ID called the CSID (Call Service ID) and a shorter name called the “CsName”. An optional ID called the “Call Alias” (or “CsAlias”) may also be created and used to identify a particular call. If you know a valid CSID,

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CsName, or Call Alias of a call, and an optional password, then the Call Service can join you into an already existing call if you meet its entrance criteria.

Note 1: The NTS CSID is a “GUID” (Globally Unique ID) that is about 20 bytes long. The CsName looks like a 10 digit telephone number, and is made of of (a) the 3-digit instance number for the Call Service creating it, (b) the digits “555", and finally (c) a 4-digit random number. Each CsName is unique when it is created, but the Call Service can re-use CsNames later. The Call Alias may be any label desired, but a Call Service will not allow duplicate Call Aliases at one time.

Note 2: NTS itself creates the CSID and CsName for a call, but humans can specify the “CsAlias”. Sometimes it is useful to assign the CsAlias of a call equal to the phone number of someone calling into NTS. Using a valid CsAlias, CsName, or CSID, NTS can find the correct call matching this name to “join” to this call and so on. See the discussion of NTS “Placeholder Calls” for an example of how the CsAlias name can be used.

An important table in the central NTS database maintained by Call Services is the “Call Conference Table”. Every time a Call Service creates a new NTS call, it creates a new entry in the central Call Conference Table. When this call ends, the CS will delete this entry. So all active calls in the NTS system can be seen in this central database table. A call entry in the central Call Conference Table includes the CSID, Csname, and CsAlias discussed above, and each call entry includes additional information such as the IP address of the Call Service supporting this call and the time stamp of when this call was created. Each entry in the table also includes additional user fields. These user fields can be updated during an active call. The NTS “Call Monitor”, available as an NTS administrator module, can show all active calls in an NTS system using this type of information.

The Call Monitor, at startup, will read this table to get in synch with existing calls, but will then tap into a Channel Service to receive a live feed of call creation and deletion.

The NTS 7 Call Service was designed to set up and manage text, voice, and video streams in a single call.

B1e. Call Flow Processor Services (CFP-S)

The NTS CFP-S is an important NTS service and creates much flexibility in NTS operations. The CFP-S has been extensively re-worked in version 6. NTS 7 adopts an industry standard script language called

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"Lua". For information on Lua, see the www.lua.org web site.

NTS scripts are normally created using a "drag and drop" graphical tool provided as an NTS administrator module. The drag-and-drop has an extensive selection of blocks, and most customer needs can be satisfied using these blocks. For special cases or needs, NXi's programmers can create a new "block", and this new block can be imported into any script. The new block will include the Lua script defining its functions.

The above capability is very useful and powerful. Suppose an NTS customer has a special requirement. NXi's programmers can write custom Lua code to satisfy these requirements, and send a new call flow "block" to the NTS customer. The NTS customer can then import this block, and use it within any NTS script. The NTS block, when opened to its Properties, will allow any configuration information (including from script variables) to be set by the customer. The new block can also return script variables to be used elsewhere within the main script.

- Note: There is one exception to the above rule that only the CFP-S runs NTS scripts. A limited script "engine" has been designed into the NTS client. This engine is used to support script-driven "pop-up" forms delivered to an NTS client. The scripting engine built into the NTS client means that any form can be designed, using Lua scripts, to meet specific needs. A Lua-generated Windows form delivered to an NTS client can have a wide variety of drop down menus, text boxes. radio buttons, and so on, and the NTS user may interact with these forms by typing or making selections. The NTS user's actions are returned to the CFP-S script creating the pop-up form. This means that a Lua script in the CFP-S can interact with NTS users to send information and retrieve feedback.
    - A good example of a Lua-driven pop-up form to a NTS user is the "One-Nbr" form. See the flyer and other material on "One-Nbr" features.

Many operations in NTS are script driven or script mediated. NTS supports internal "system scripts" that assist internal NTS operations, and "user scripts" that are created by customers or organizations using NTS. An example of an NTS "system script" is the "cs_dial" script. Most NTS calls, such as from one NTS client to another or from the TS to a client, are mediated by this system script.

If a script is needed during a NTS call, then the Call Service creates a call leg to the CFP Service. Text choices, responses, etc. are then routed to and from the CS to the script being run in the CFP-S.

Scripts in NTS are created and maintained in a "Scripts" administrator module. Scripts are "owned" by any NTS user or group, so any NTS user or group can own a unique collection of NTS scripts.

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-- Note: Most NTS system scripts are owned by the “Services” group in the domain.

B2. NTS “Gateways”

General Note: An NTS “gateway” is something that converts some “foreign” protocol or system to native NTS protocols. For example, the NTS Telephony Server gateway converts the “telephone world” of phone lines, voice telephones, and TTYs to the NTS world of TCP and UDP packets compatible with the Call Service and other NTS services. NTS gateways are described below.

B2a. Telephony Server (TS) gateway

An important NTS service is the Telephony Server gateway. As mentioned above, this gateway converts the “telephone world” of phone lines, voice telephones, and the TTY devices used by the deaf to the “IP” world of Call Services, and so on.

In order to connect directly to phone lines, the TS requires hardware in the form of a “telephony card” or telephony hardware of some type. The telephony hardware used by the TS is the only specialized hardware needed by NTS. NTS 7 supports a variety of telephony cards, including 4-port analog phone line cards, and digital T1 cards supporting one, two, or four T1 lines. The T1 cards can support 24, 48, or 96 telephone calls at once to voice telephones or TTYs over phone lines.

The NTS TS in version 7 supports (a) Baudot 45 and 50 baud, (b) Bell 103 and V.21 (300 baud), (c) the playing audio of audio recordings, support for faxing (inbound and outbound), streaming audio (VoIP), recording audio, and support for the TTY protocols used by deaf persons in Europe, including EDT (European Deaf Telephone), V.23 (used in France), and the DTMF Q.23 protocol.

B2b. Remote Proxy Service (RPS)

In NTS versions 4.0 and 5.0, NTS services and clients created a persistent encrypted TCP/IP connection FROM the service or client TO the NTS 4/5 “Connection Processor” (CP). As long as the IP address and port of the CP could be “seen” from the NTS client or other service, then this persistent connection could be formed to the CP. Both incoming and outgoing NTS calls and other information would then travel on this persistent TCP/IP network connection. This encrypted persistent connection is a type of “VPN tunnel”.

Each NTS service logs in, or registers, with a Locator Service. So, another NTS service can find this information from a Locator Service, and connect directly to any service as needed. NTS service-to-service

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communications do not go through the Call Service, and there are built-in load balancing algorithms in connecting to multiple instances of a given service. This NTS-7 strategy will scale to large systems, and handles redundancy and failover issues among NTS services.

The NTS client does not connect and behave like an NTS "service"; instead, NTS clients create a connection to an NTS "Remote Proxy Service" (RPS).

The NTS 7 RPS supports two connection types or strategies to NTS clients: (a) a persistent TCP/IP connection using 256 bit AES encryption called "IIOP" (normally using port 2591), and (b) a 256 bit SSL encrypted HTTP protocol ("HTTPS") on port 443.

The NTS RPS Gateway "listens" on two TCP/IP ports: 2591 and 443. If an NTS client contacts the RPS on port 2591, then the RPS will attempt a connection and login using the IIOP strategy. If the NTS client contacts the RPS on port 443, then the RPS will support a client login using the HTTPS strategy.

The IIOP connection type is explained first below.

(a) The "IIOP" connection strategy for RPS-to-client connections:

> The NTS-7 RPS, using IIOP, was designed to provide the same types of NTS client-to-server connections as the earlier "CP" provided in the NTS 4.0 or 5.0 architectures. So, a NTS client software connects *to* the RPS and creates a single persistent encrypted TCP/IP connection. As long as the NTS client can "see" the RPS IP address and port, this connection can be made. The NTS client does not need any other connections for TCP/IP communications.
>
> The persistent, 256 bit AES encrypted, TCP/IP connection established from the NTS client to the RPS Gateway is, in effect, a "VPN tunnel". Both outgoing, and incoming, NTS calls and messages travel on this encrypted link from/to the NTS system and the NTS client.
>
> At login, the NTS client can establish a persistent TCP/IP connection to the RPS on port 2591 and pass across its login information. The RPS will then talk to a Locator Service for this login. The Locator Service will validate the login request. This validation may use the organization's Active Directory or other LDAP database. After login, suppose a NTS client wishes to make a call to another NTS client. This call request will travel on the persistent TCP/IP connection to the RPS Gateway. The RPS will then contact the Locator Service to find a Call Service, and

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create a persistent “call leg” from itself to a call object in the Call Service. The CS will then typically create an outdial from this call object to the desired destination.

Each single encrypted link between an RPS Gateway and a client can support any number of individual calls, each with any number of participants. Multiple RPS modules may be installed in a single NTS system to scale to large systems.

Suppose a NTS client is in one or more calls through the RPS, but the persistent TCP/IP connection between the client and the RPS is momentarily broken. The RPS is tolerant of this condition, and will set an internal timer. If the client re-establishes its connection with the RPS before this timer expires, then the RPS will continue this client’s calls without interruption. The NTS Call Service will not be made aware of this temporary break in such as case.

(b) The “HTTPS” connection strategy for RPS-to-client connections:

The second connection strategy used by the RPS will be discussed below. This second connection type uses an SSL encrypted HTTP protocol on port 443.

HTTP stands for “HyperText Transfer Protocol”, and is the protocol commonly used between web servers and browsers. If the communication between a web server and a browser is encrypted using SSL (“Secure Socket Layer”) then the connection is called “HTTPS”.

Many organizational firewalls will allow a true HTTP, or HTTPS, communication between a web server on the organization’s network DMZ and external browsers. The HTTP protocol normally uses TCP/IP port 80, while HTTPS normally uses port 443.

In HPPTS mode the NTS server’s RPS Gateway is acting like a web server, and the NTS client is acting like a browser in how they communicate. Many network firewalls can analyze HTTP packets, and some organizations may allow HTTP or HTTPS links where other types of encrypted connections would not be allowed. So an NTS client can communicate with an NTS server using a browser/web server protocol if desired.

B2c. Internet Gateway (IG)

The NTS Internet Gateway role in the NTS architecture is to allow text chat calls from browsers to enter the NTS system.

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In most cases a browser call into NTS is launched from a web page such as the www.nextalk.net site or an NTS customer web site. A web browser user may see an icon labeled “Chat” or “Live Assistance” or similar on a main web page. This web page can simply include an “href” link pointing to the NTS Internet Gateway, and this link is processed if the browser user clicks on this icon. So, when the browser user clicks on this icon, their browser is directed to the NTS IG, and the IG sends across a specialized Java applet to the browser. This applet in turn will communicate back to the IG using HTTP. The HTML code on the main web page can include an NTS destination for this browser call, and this information will be sent into NTS by the applet. So, the browser call can be routed to any NTS destination. NTS destinations are typically a particular user, a department, or an NTS script. In the NTS 7 system IG calls from browsers, like all calls, will be set up through the Call Service.

Text chat from a browser user and an endpoint in the NTS system should be encrypted for security. This may be achieved by placing a standard web server such as Apache or IIS between the browser user and the NTS IG. This technique is used, for example, in the www.nextalk.net site to achieve SSL encryption of text communications to any browser using this site.

Contact NXi for further details on the IG and its associated Java applet.

B2d. SMTP Gateway (SMTP-GW)

The NTS SMPT Gateway sends emails.

In order not to compromise NTS’s security model, the NTS SMTP Gateway does not currently support file attachments of any type.

As discussed elsewhere, each NTS user or department’s NTS “mailbox” supports forwarding to up to four email addresses. A given NTS user may never log into the system, but if a text user calls them (from a TTY, browser, NTS client, a video call, etc), they will get this person’s mailbox greeting and can leave a text message. The NTS Message Notification Service can then forward this text message to this person’s normal email addresses.

B2e. NTS Inter-Domain Calling Gateway (IDC-GW)

One NTS system can call a “remote” NTS domain in several ways, including a telephony call. A “remote” NTS domain is one which does not reside in the same database as the local domain.

It is the NTS Inter-Domain Calling Gateway which allows “native” NTS TCP/IP calls between separate NTS systems. The IDC-GW is optional in a given NTS system.

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The IDC-GW, if installed, accepts SSL encrypted HTTP protocol calls ("HTTPS") on port 443. In operation, the IDC-GW accepts incoming HTTPS formatted calls from a remote NTS system. Such a call leaves a local NTS Call Service and enters the remote NTS system using the remote domain's IDC-GW.

In order for NTS domain A to call a remote NTS domain B, the IP address and port of domain B's IDC-GW must be entered in domain A's "Remote Domains" table. This table may be edited by an NTS administrator.

Note that not all calls between NTS domains use the IDC-GW. If two NTS "sub-domains", for example, share a common NTS database then the IDC-GW is not used or needed for such inter-domain calls.

B2f. SQL Gateway

The SQL Gateway allows any "ad hoc" SQL commands or queries to any database. Use of the SQL Gateway by NTS is a NTS "Lua" script driven feature.

The combination of NTS scripts, and the SQL Gateway, is a powerful combination.

-- Using any customer provided database, an NTS script can use custom SQL queries to obtain any information and return this information to the script. The NTS script can then use this information in any manner desired. One example would be to provide information to an NTS end-point such as a deaf person using a TTY, a browser "caller", a wireless user, and so on.

-- The SQL Gateway also allows any NTS script to (a) create any database tables desired and (b) store & retrieve information from these new tables. This means that a given NTS system can be customized easily to support any type of information useful to the NTS customer.

B2g. SIP Telephony Server (SIP-TS)

The SIP-TS is a gateway service in NTS that supports VoIP (Voice over IP) telephone calls.

What are SIP and VoIP ?

VoIP stands for "Voice over IP". VoIP techniques allow a phone call to travel over a data network like the Internet or an organization's LAN or WAN. So, using VoIP, phone calls travel over the same wires as computer data. Voice sounds are digitized and sent as "UDP" packets on the network. The voice sounds are digitized with an audio "codec" which stands for "Coder / Decoder". The sounds of your voice are "coded" into digital 1's and 0's, sent over a data network, then "decoded" back to

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sound. Commonly used audio codecs for VoIP calls include G.711, G.723, and G.729. Codecs compress the audio data into less data, and some codecs compress more than others.

In a VoIP call, the audio codec used sends sounds over a data network, but how is the call itself set up? In other words, what protocol is used to ring a remote destination, answer the call, negotiate a compatible codec agreeable to both sides, and so on? There are two call set-up standards used for VoIP calls: (a) SIP and (b) H.323. SIP is most commonly used for private phone systems. "SIP" stands for "Session Initiated Protocol".

Description of the SIP-TS Gateway in NTS

***

What are some advantages of the SIP-TS Gateway?

***

What phone switches work with NTS's SIP-TS ?

***

B3. Additional NTS system services

General Note: Section B1 above, "Basic NTS services for system operation", described certain core NTS services needed for basic operations of the NTS system. In this Section B3, additional NTS services are described.

B3a. Message Notification Services (MNS)
B3b. Message Deliver Services (MDS)
B3c. Queuing Service (QS)

The NTS Message Notification Service (MNS) and the Message Delivery Service (MDS) are responsible for two functions: (a) managing NTS instant messaging, including PopUp instant messages and Message Notifications, and (b) managing NTS user and department mailboxes. In operation, MNS and MDS use the Queuing Service (QS).

NTS instant messaging and Notifications.

The NTS MNS/MDS/QS, and the CFP-S, work together to deliver instant messages and Notifications in the NTS system. The MNS analyzes a particular job into delivery tasks, the tasks are queued in the QS, and the MDS is then responsible for processing these delivery tasks.

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In operation, MDS takes each IM or Notification to be delivered from the QS, and hands it off to the CFP-S to be delivered using an NTS delivery script. A delivery script typically can branch in different directions based on conditions or errors, and since each IM or Notification script is run independently, the delivery of each message can adapt to different conditions. For example, a voice or text Notification delivered to a phone number can adapt to busy or invalid numbers, input from the called party, and so on for each number dialed. A delivery script will report back the success or failure of a delivery task back to MNS, and MNS will record this information in the central database for later reporting.

NTS calls and mailboxes:

> Calling in NTS is a good example of how NTS uses “system scripts”. NTS calls are mediated by the “cs_dial” system script. If a call to a NTS user is not answered, then the calling party is directed by the cs_dial script to the “take_message” system script. The take_message script will obtain the Take Message Greeting for the group or user being called, send this greeting, and accept a message from a caller. This script then writes the message to the central database for forwarding to email or later viewing by the user or a group member.
>
> It should be noted that NTS users, from their client software, can view mailbox messages left for departments of which they are a member.

For further information on NTS mailboxes, see the NTS User Guide, and the NTS Admin manual.

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B3d. Device Services (DVS)

The role of the NTS Device Services service is to control the use of telephony ports needed for telephony calls.

An outbound TS call over the PSTN (Public Switched Telephone Network) can involve significant long-distance phone charges. TS calls also tie up TS port resources, so many organizations need control of NTS TS ports used for outgoing calls. The DVS performs this role.

If an NTS client, script, Message Notification Service, etc. wants to make an outbound TS call, it will present all relevant information about this call to the DVS. Relevant information includes the phone number to be dialed, and the "Resource Group" for the call. The DVS will then find an appropriate port in the NTS system among all the TS's available. The DVS will then return (a) the IP address of the selected TS, (b) the device number of the port selected, and (c) a port "Reservation Number". The NTS client, or script, will then create a call to the indicated TS and present the three data elements above. The TS will then link this call to the indicated TS port, and dial the phone number of the call out onto the analog or digital phone line.

Further details on DVS operation can be found in the document "DVS_Res_Group_Design.doc".

B4. New services in NTS-7

B4a. Video ESC and ECR Gateways

In NTS version 7 there are two NTS servers: the traditional or main NTS server, plus a new NTS "Video Server" used in video conferencing calls. Some organizations may elect to run the main NTS server on-site, but use a hosted NTS Video Server off-site. In these cases, what communications are needed between these two NTS server types?

Communications between the main NTS server, and the NTS Video server, occur using the NTS ECR and ESC gateways. Both of these gateways are run on the main NTS server, and each logs into the NTS Video Server on port 443 using an encrypted SSL connection. Connections back to these gateways occur on Port 80, or any desired port set during the installation of these gateways.

Note: Both the ECR and ESC Gateways are designated as simply the "VECR Gateway" on the accompanying network diagrams. These two gateways are normally run together and this was done for simplicity.

Communications originating from the main NTS server going to the NTS Video Server occur on the ESC Gateway, while communications originating from the

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NTS Video Server and going to the main NTS server occur on the ECR Gateway.

The NTS ECR Gateway is used for video call routing to a destination, where a video call arrives at the NTS Video Server first. Video calls from H.323 Video Phones, and video calls from the NTS Active-X control running on a browser, each arrive first at the NTS Video Server. The NTS Video Server then posts a request to the ECR Gateway running on a main NTS server for a destination for this call. The main NTS server finds a destination, usually using an NTS script, and returns this destination to the Video Server to complete the video call.

The NTS ESC Gateway is used for commands and directives originating from the main NTS server traveling to the NTS Video Server. Examples of these directives include (a) setting up a multi-party video call in the Video Server, (b) since each NTS client video-module registers with the Video Server, the main NTS server sets up permissioning for individual NTS users in the Video Server using the ESC Gateway.

It is noted that installing and running the ECR and ESC Gateways are optional. If a given NTS organization does not wish to accept and route H.323 Video Phone calls or browser calls, then the ECR Gateway is not needed. If the NTS organization wishes to set up user permissioning manually or in another fashion, then the ESC Gateway is not needed.

Summary of IP addresses and ports needed for ECR and ESC Gateway operation. From the main NTS server only, the following two port communications are needed:

-- Port 443 bidirectional to 75.125.90.242 to 75.125.90.247
-- Port 80 inbound from 75.125.90.242 to 75.125.90.247

Note that the two ports above are needed only between the main NTS server and the NTS Video Server addresses shown, and not from each NTS client. For the NTS client making video calls, as discussed above, all NTS client machines need only port 1853 outbound to 75.125.90.242 to 75.125.90.247. All NTS client machines will log into the main NTS server on port 2591 for basic operation, so an NTS client machine needs at most two outbound ports for operation.

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B4b. Conferencing Service

NTS-7 supports conference calls of multiple types. For example, NTS has long supported text conference calls of two types: (a) split-screen text conversations with up to 10 participants, and (b) “IM Chat” style text conferences with any number of participants. New in NTS-7 are audio conferences and video conferences. Suppose the same group of people are participating in the same text, audio, and/or video conferences within NTS? In this case there is a notion of a single conference call that is made up of multiple text, audio, and video sub-conference calls.

Each conference call within NTS, of any type, is considered to have real or potential associated conferences of type text, audio, and video. In other words, even a simple text conference call may “activate” audio and video conferences, and a purely video or audio conference may “activate” an associated text conference.

The role of the NTS-7 Conferencing Service is to manage and integrate multiple sub-conferences into a single higher level conference call among a group of participants.

An example use for the Conferencing Service is as follows. Suppose a group of NTS users are in an NTS text conversation, and these users wish to activate a video conference call among themselves. An NTS user may click “Video” on their text chat window. At this point the NTS client program links to the NTS Conferencing Service, and requests instructions how to join the video conference associated with the current text conference. The Conferencing Service will start a video conference call within the NTS Video Server if needed, and will then send call ID’s and instructions to the requesting NTS client how to join the associated video conference. The Conferencing Service maintains tables linking text, audio, and video sub-conferences into a single higher-level conference among specified participants.

B4c. Call Detail Recording Service

The NTS Call Detail Recording Service (“CDR Service”) manages system activitty recording within NTS.

New CDR events, with defined parameters, may be added to the NTS system via the admin module called the “Call Data Event Editor”. NTS scripts may “fire” such CDR events. in most cases CDR events are sent to the Call Service managing a particular call. Such CDR events are typically sent out a channel on the Channel Service, but in any event the Call Service takes all accumulated CDR events that occurred during a call, and at the conclusion ofo the call sends them to the CDR Service. The CDR Service then writes these CDR events out to the CDR database.

See the white paper “CDR Overview in NTS” for further details.

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B4d. Monitoring Service

There are five “Availability Monitors” within the NTS system. These are the Process Monitor, Diagnostics Monitor, Scripts Monitor, Errors Monitor, and the Ping Monitor. Each of these monitors is used to monitor the activity and health of NTS systems.

The NTS Monitoring Service manages and controls the monitoring services above.

See the on-line help guide for each of the services above for further details.

B4e ACD Service

A good name for the NTS “ACD Service” might have been the NTS “Find Agent Service” since this is its role in the architecture. In the call center industry, a module that finds an agent for a caller is referred to as the ”Automatic Call Distribution” service, or ACD service, this this module distributes calls to agents.

If an “agent” is needed to handle a call within NTS, then the script or NTS client may pass this request, along with known information, to the NTS ACD Service. Known information can include the skills needed by the agent, phone numbers or other information on the caller, and so on. It is the role of the NTS ACD Service to find an agent for the request.

In practice, the ACD Service calls NTS scripts to perform its functions, so the operation of the ACD Services is highly configurable.

B4f Scheduler Service

Script names may be entered into the NTS Scheduler Service GUI, and this service will run such scripts at set intervals, or one-time, as desired. The Scheduler Service GUI allows information, in token=value form, to be specified and this information will be fed to the script at each start-up event.

B4g Curl Service

Curl, sometimes spelled cURL, is an open-source protocol for obtaining information and interacting with internet services of type ftp, http, LDAP, and many others. See the Wikipedia article “http://en.wikipedia.org/wiki/CURL”.

Within the NTS architecture, information and commands to internet servers may be employed via the NTS Curl Service.

An example use of the Curl Service will be given. One of NXi’s developers used the Curl Service, as well as the new Scheduler Service and the new NTS Text-to-Speech Service, to create a wake-up call each morning. An NTS script is launched at 6 a.m. every weekday, and it posts a query, via a Curl Service, to a web site with the day’s weather forecast. Then, this script creates a telephony call to the phone for this developer, and using Text-to-Speech, gives a cheery

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greeting and delivers the day's weather forecast over the phone.

B4h. Asterisk AGI Gateway Service

"Asterisk" is an open-source IP phone system. See www.asterisk .com.

NTS-7 supports a gateway into an Asterisk phone system with a wide range of Asterisk commands and directives. In this way, an NTS system can control and interact with an Asterisk phone system.

B4i. Text-to-Speech Service

The NTS-7 Text-to-Speech Service ("T/S Service") accepts text strings and turns these into spoken English. The NTS T/S Service may be controlled by NTS scripts. See the Curl Service above for an example use of the NTS Text-to-Speech Services module.

B4. NTS Client Application

The NTS client is the NTS program typically run on user's computers. The NTS client is also called the "NexTalk" program.

Privilege levels for NexTalk users

All NTS users run the same NexTalk software, but administrator Joe will get more power in the NTS system than end-user Fred. How is this managed? NTS manages these notions by linking or assigning capabilities to NTS "groups". The "Administrators" group will have top-level capabilities, the "Everybody" group may have little, and the "Supervisors" group may be given intermediate capabilities. The privileges associated with each NTS group is set in the "Users & Groups" admin module. Each NTS user is linked to just one "Default Group", and each NTS user gets his or her NTS privileges from this membership. NTS users may belong to many NTS groups, but each NTS user is linked to just one Default Group.

Further information on the NTS client may be found in the NTS 7 User's Guide.

B5. Launching and managing NTS services

B5a. Process Manager (PM)

See the on-line Help manual for the PM.

B5b. PM Administrator (PMA)

See the on-line Help manual for the PMA.

C. General NTS Topics

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C1. NTS Subdomains and Remote Domains

An NTS "domain" is a community of users, groups, scripts, and so on. NTS users in a domain will usually see each in their NTS phone books. You can call another user in your NTS domain by using their login name only. So Joe Smith might call Sally Jones by simply typing "sally" as the call destination, if Joe and Sally are in the same NTS domain.

In some cases you can call to a different NTS domain. In this case you will specify the domain name, as in "sally@abc.gov". If your NTS domain can connect to the "abc.gov" domain, then your call to Sally in this foreign domain will work.

"Foreign" NTS domains come in two flavors: (a) remote domains and (b) subdomains.

A remote NTS domain is an NTS domain that uses a different database than yours. It is a completely different NTS system than the one your NTS account was created in. Almost all organizations running NTS will create just one domain for their NTS system.

A new feature in NTS-7 is the ability for NTS to support any number of NTS domains within a single database and single NTS system.. This NTS-7 feature is used by NXi to create "hosted NTS domains" or systems for organizations. Certain NTS partner companies may also create subdomains, and certain large NTS sites like the National Institutes of Health have created NTS subdomains within a single NTS system's database. In the case of NIH, each institute is its own NTS subdomain, all residing in a single NTS system maintained by the central NIH CIT division.

NTS subdomains support NTS administrators, and these administrators can create their own users, groups, scripts, and so on within this subdomain.

NTS supports a notion of a "base domain" in any system. Only the base domain NTS administrator can create new subdomains and perform certain other configurations as discussed below.

Creating subdomains in an NTS system does not mean that additional NTS service processes are needed on the NTS server(s). Suppose there was a single NTS server running a single instance of each NTS module or process like Locator Service, Call Service, Call Flow Processor, and so on. This NTS system could support hundreds of subdomains using this single set of NTS services. Each NTS service is "subdomain aware" and can run each subdomain as a separate entity. For users and administrators, a subdomain looks, for the most part, like a separate NTS system.

The phrase above said subdomains look like separate system domains "for the most part". There are a few exceptions to this rule. Only the NTS "base domain" administrator can install and manage NTS gateways like Telephony Servers, Internet Gateways, and so on. Only a base domain administrator can create new subdomains, or configure access to remote domains.

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D. Technical NTS Topics

D1. The NTS Service Framework and low level NTS connection strategies

This section describes how connections are managed in NTS 7 between services like NTS services, gateways, and clients. The goals behind these NTS connection strategies include load balancing, failover, and scalability. These strategies are largely implemented in the Service Framework underlying all NTS services and the Locator Services.

D1a. Summary of operation for NTS calls.

Suppose one NTS service wishes to communicate with another NTS service. Generally, the calling service will place a request to a Locator Service, and receive back a list of IPAs (IP addresses) and listening ports for instances of the desired services. The calling service will then use this list to contact the desired service. The logic used in handling this list and creating a connection is handled in the "Service Framework" underlying all NTS services.

When a Locator Services receives a locator request, it will create and return a listing of IPA/ports for the service being called. This listing will be organized in the ordered groups as shown below. The order of IPAs/ports within each group will be randomized on each new locator request.

- Group 1: IPA/ports of service instances matching the entire IPA of the requesting service.
- Group 2: IPA/ports of service instances matching the first three octets of the IPA of the requesting service.
- Group 3: IPA/ports of service instances matching the first two octets of the IPA of the requesting service.
- Group 4: IPA/ports of service instances matching the first octet of the IPA of the requesting service.
- Group 5: IPA/ports of service instances that do not match any octet of the IPA of the requesting service.

In practice, there will rarely be more than two groups returned. The Service Framework handles the list above in the same way for all connections.

Suppose one NTS service is contacting another, or a NTS client is calling a service, or etc. The Service Framework uses the following strategy. Once the calling service receives the ordered list above, the Service Framework will create sequential connection attempts. The Service Framework will first try the first IPA/port in the list within Group 1. Group 1 destinations will reside on the same machine as the calling service. If this initial connection attempt fails, it will next try the next IPA/port (if any) in Group 2. If connection attempts continue to fail, the Service Framework will work its way down through Groups 3, 4, and 5 by trying each IPA/port in this list, one at a time

- Note: The mechanism above is inherently load balancing within a group. Since the Locator Service randomizes the IPA/ports on each

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locator request, all instances of a service within a group will receive incoming calls and will tend to load balance.

-- Note: The mechanism above means that the calling service will use more local instances of the called party service as compared to more distant instances. So, for example, if a Telephony Service is calling a Call Service, this call will naturally form between this TS and any local CSs on the same machine.

D1b. The connection strategy of "connection re-use"

In many cases a particular NTS service will make repeated connections with another particular NTS service type. For example, many NTS services will make repeated information requests to the Data Services service. Gateway services tend to make repeated connections with Locator Services, Device Services, and so on. Creating and tearing down TCP/IP network connections creates takes time and CPU cycles, so an optimization called "connection re-use" was done in the Service Framework.

Suppose a given NTS service needs to communicate with another NTS service type. Perhaps a RPS gateway needs to make repeated requests to a Locator Service or a DS on behalf of its clients, or the Message Notification Service (MNS) needs to communicate repeatedly with the DS to access information. In this second example, the first time this need arises the MNS will contact a Locator Service and get back all the locations of DS instances in the system. Maybe there are three DS instances running, the MNS connects to one of them, and makes its information request.

The Service Framework does not immediately tear down a TCP/IP connection at the completion of a call or RPC transaction. Instead, the Service Framework starts a timer and only tears down this connection if the timer expires. In the present example, if the Message Notification Service needs to connect to a DS again later, the Service Framework accepts this connection request and checks first if it already has a connection to the indicated service type. If the earlier MNS-to-DS connection is still in place, then the Service Frame will not contact the Locator Service at all, and will simply pass this already existing connection back up to the requesting NTS application (the MNS). This feature is called "connection re-use".

It should be noted that the connection re-use feature off-loads the Locator Services, the network, and the NTS system. If two NTS services talk repeatedly to each other, then a "semi-persistent' connection will form between these services and be re-used repeatedly. If the "called" service fails, then NTS redundancy will still operate, but in active NTS systems these "temporary but stable" connections will tend to form.

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D2. NTS logins and "Session Cookies"

When a NTS service (service, gateway, or client) logs in then a Session Cookie is returned with an expiration time stamp. The service must contact a Locator Service and renew this Session Cookie before it expires, or NTS will log this service out.

-- Note: The approach above means that NTS will not know a service, like a client, has crashed and not logged out normally until its Session Cookie expires. This time duration can be shortened by making the Session Cookie refresh interval shorter. This interval is usually set in the 3 minute range, and this is the same time-out that a persistent connection would have if a computer crashed or a cable was unplugged.

***** END DOCUMENT *****