Entertainment Services and Technology Association

ESTA

American National Standard
E1.30-7 - 2009
EPI 29
Allocation of Internet Protocol
Version 4 Addresses to ACN Hosts

Part of the E1.30 suite of documents that offer application level equipment interoperability for control of commonly encountered entertainment technology devices using E1.17

CP/2008-1010r2

[inside front cover]

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This document was approved as an American National Standard by the ANSI Board of Standards Review on 14 September 2009.

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Published by:
Entertainment Services and Technology Association
875 Sixth Avenue, Suite 1005
New York, NY 10001 USA
Phone: 1-212-244-1505
Fax: 1-212-244-1502
standards@esta.org
http://www.esta.org/

For additional copies of this document contact:
ESTA Publications
The ESTA Foundation
875 Sixth Avenue, Suite 1005
New York, NY 10001 USA
Phone: 1-212-244-1505
Fax: 1-212-244-1502
http://www.estafoundation.org

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The Control Protocols Working Group, which authored this Standard, consists of a cross section of entertainment industry professionals representing a diversity of interests. ESTA is committed to developing consensus-based standards and recommended practices in an open setting. Future Control Protocols Working Group projects will include updating this publication as changes in technology and experience warrant, as well as developing new standards and recommended practices for the benefit of the entertainment industry.

Contact Information

Entertainment Services and Technology Association
Karl G. Ruling
Technical Standards Manager
ESTA
875 Sixth Avenue, Suite 1005
New York, NY 10001
Phone: 1-212-244-1505
FAX: 1-212-244-1502
standards@esta.org

Technical Standards Committee Chairperson
Mike Garl
James Thomas Engineering, Inc.
10240 Caneel Drive
Knoxville, TN 37931
Phone: 1-865-692-3060
FAX: 1-865-692-9020
mikeg@jthomaseng.com

Control Protocols Working Group Chairpersons
Michael Lay
Philips Strand Lighting
6603 Darin Way
Cypress, CA 90630
Phone: 1-714-230-8208
FAX: 1-714-899-0042
michael.lay@philips.com

Tracy Underhill
Electronics Diversified LLC
1675 NW Cornelius Pass Rd.
Hillsboro, OR 97124
Phone: 1-503-645-5533
FAX: 1-503-629-9877
tracy.underhill@edionline.com

Acknowledgments

The Control Protocols Working Group was the consensus body for the development of this Standard. The working group's membership when the motion was made to approve this document as an American National Standard on 23 October 2008 is shown below. The voting by letter ballot closed on 24 January 2009.

Voting members:

Daniel W. Antonuk; Electronic Theatre Controls, Inc. [MP]
Robert Armstrong; Pathway Connectivity Inc. [MP]
Robert Bell; Horizon Control Inc. [MP]
Scott M. Blair; High End Systems Inc. (Barco) [MP]
Ron Bonner; PLASA [G]
John (Javid) D. Butler; Integrated Theatre, Inc. [CP]
Jean-Francois Canuel; Spectrum Manufacturing Inc. (A.C. Lighting Ltd.) [CP]
Kimberly Corbett; Schuler Shook [G]
Stuart Cotts; Oregon Shakespeare Festival [U]
Milton Davis; Doug Fleenor Design, Inc. [MP]
Gary Douglas; Horizon Control Inc. [MP]
Doug Fleenor; Doug Fleenor Design, Inc. [MP]
Robert Goddard; Goddard Design Co. [MP]
Tom Grimes; High End Systems, Inc. (Barco) [MP]
Dennis Grow; I.A.T.S.E. Local 728 [U]
Mitch Hefter; Entertainment Technology (Royal Philips Electronics), representing USITT [U]
Dave Higgins; Pathway Connectivity Inc. [MP]
Simon Hobday; Artistic Licence (UK) Ltd. [CP]
John Huntington; City Tech, Ent Tech Department, representing I.A.T.S.E. Local 1 [U]
Edwin S. Kramer; I.A.T.S.E. Local 1 [U]
Ulrich Kunkel; E3 Engineering & Education for Entertainment, representing the DIN, NVBF Committee [U]
Roger Lattin; I.A.T.S.E .Local 728 [U]
Hans Lau; Sand Network Systems, Inc. [MP]
Michael Lay; Strand Lighting (Royal Philips Electronics) [MP]
Rick Leinen; Colortran (Leviton Manufacturing Co., Inc.) [MP]
Kevin Loewen; Pathway Connectivity Inc. [MP]
Mark Manthei; Shure Inc.; [G]
Alan Martello; Horizon Control Inc. [MP]
Tyrone Mellon Jr.; Lex Products Corp. [CP]
Philip Nye; Engineering Arts; [G]
Edward A. (Ted) Paget; Vortek Rigging Division, Daktronics Inc. [G]
Charles Reese; Production Resource Group [DR]
Alan M. Rowe; IATSE Local 728 [U]
Yngve Sandboe; Sand Network Systems, Inc. [MP]
Arnold Tang; Arnold Tang Productions [U]
Steve Terry; Electronic Theatre Controls [MP]
Robert Tooker; Production Resource Group [DR]
Tracy Underhill; Electronics Diversified LLC [MP]
Ken Vannice; Colortran(Leviton Manufacturing Co., Inc.) [MP]
Michael (Mike) Whetstone; Integrated Theatre, Inc. [CP]
Peter Willis; Howard Eaton Lighting Ltd. [CP]
Kehang Wu; Shure Inc. [G]

Observer members:

Simon Alpert; Lighttech Event Technologies [CP]
Klaus Amling; Licht-Technik; P
Shahid Anwar; Avolites Ltd. [MP]
Tim Bachman; A.C.T Lighting, Inc. [DR]
Robert Barbagallo; Solotech Inc. [U]
William Benner; Pangolin Laser Systems [MP]
Adam Bennette; Electronic Theatre Controls, Inc. [MP]
David Bertenshaw [G]
Stephen Bickford; T. Kondos Associates [U]
Torrey Bievenour; Vision Quest Lighting [G]
Mike Blackwell; Philips/Color Kinetics (Royal Philips Electronics) [MP]
Lee J. Bloch; Bloch Design Group, Inc. [G]
David A. Boller; Organic Machines LLC [CP]
Andre Broucke; ADB - TTV Technologies (ADB-TTV Group) [MP]
Steve Carlson; High Speed Design, Inc. [MP]
Soo-Myong Chung; Bloch Design Group, Inc. [G]
Paul J. Clark; HxDx [CP]
Edward R. Condit [G]
Eric Cornwell; West Side Systems [U]
Klas Dalbjorn; Labgruppen AB (TC Group) [MP]
Gary Dove; Dove Systems [MP]
Larry Dunn; City Theatrical, Inc. [CP]
Jerry Durand; Durand Interstellar, Inc. [CP]
James Eade; PLASA [G]
Joost van Eenbergen; ELC Lighting [MP]
Anders Ekvall; Electronic Theatre Controls, Inc. [MP]
Bill Ellis; Candela Controls, Inc. [U]
Paul K. Ericson; Syska Hennessy Group Lighting Design [U]
Jon R. Farley; Sixteenth Avenue Systems [CP]
Martin Farnik; Robe Show Lighting s.r.o. [MP]
Bill Fehrmann; Electrol Engineering, Inc. [MP]
Trevor Forrest; Helvar Lighting Control [MP]
Douglas Franz; QVC Network [U]
Steve Friedlander; Auerbach Pollock Friedlander [U]
Michael Gonzales; Spectrum Lighting Inc. [DR]
Jerry Gorrell; Theatre Safety Programs [G]
Josh Gubler [CP]
Sean Harding; Rhode Island College [U]
Bill Hewlett; Hewlett Electronics [CP]
Helge Hoffmann; JB Lighting [MP]
Jim Holladay; Luxence [G]
Wayne David Howell; Artistic Licence (UK) Ltd. [CP]
Sierk Janszen; Kiss Box (Ground Zero) [U]
Flemming Jensen; Martin Professional A/S [G]
Eric Johnson [MP]
Rob Johnston; Interactive Technologies, Inc. [MP]
Ed Jones; Edwin Jones Co., Inc. [CP]
Jussi Kallioinen; Eastway Sound & Lighting [U]
Ujjal Kar; Standard Robotics & Lighting [G]
Hiroshi Kita; ; Marumo Electric Co., Ltd. [MP]
Mark T. Kraft; Lehigh Electric Products Co. [MP]
Marty Lazarus; Chicago Spotlight, Inc. [G]
Hans Leiter; Electronic Theatre Controls, Inc. [MP]
Paul F. Mardon; Pulsar Ltd. [MP]

Mick Martin; ShowCAD Control Systems [MP]
Paul Kenneth McEwan; Zero 88 Lighting Limited [MP]
John Mehltretter; Lehigh Electric Products Co. [MP]
Avraham Mendall Mor; Lightswitch [U]
Tobin Neis; Barbizon Companies [DR]
Lars F. Paape; Scientific Algorithms and Embedded Systems [U]
Fabiano Pina; Clay Paky S.P.A. [MP]
Gary Pritchard; LSC Lighting Systems PTY Ltd [MP]
Eric Proces [U]
Christopher Purpura; Jones & Phillips Associates, Inc. [G]
Torben Kaas Rasmussen; Martin Professional A/S; G
Charlie Richmond; Richmond Sound Design Ltd. [CP]
Bernardo Benito Rico; Ben-Ri Electronica S.A. [MP]
Steve Roberts; Carr & Angier [G]
Erwin Rol; Erwin Rol Software Engineering G
Dietmar Rottinghaus; Connex GmbH [G]
Richard Salzedo; Avolites Ltd. [MP]
Larry Schoeneman; Designlab Chicago, Inc. [DR]
Chuck Seifried; Phoenix Civic Plaza, City of Phoenix [U]
John Sellers; AIM Northwest [G]
Andrew Sherar; Lightmoves PLC; MP
Yehuda Shukram; Compulite Systems [MP]
John Sondericker III; Wybron, Inc. [MP]
Bart Swinnen; Luminex LCE [MP]
Geoffrey O. Thompson; Nortel Networks, Inc. [G]
David Timmins; Jands Electronics [MP]
J. B. Toby; Avolites Ltd. [MP]
Bob Toms; Catalyst Microsystems LLC [G]
Tad Trylski [U]
Stephen J. Tyrrell; Quantum Logic [MP]
Steve Unwin; Pulsar Ltd. [MP]
Dominic Vincenty; Television Production Service [DR]
Will Wagner; Carallon Ltd. [MP]
John Warwick; Philips/Color Kinetics (Royal Philips Electronics) [MP]
Colin Waters; TMB [U]
Ralph Weber; ENDL Texas [G]
Daniel Weiermann; Mainstage Theatrical Supply - Milwaukee (Mainstage Theatrical Supply) [DR]
Lars Wernlund; Lewlight [MP]
Loren Wilton; Showman Systems [CP]
Barbara Wohlsen [U]
Jiantong Wu; Beijing Special Engineering Design & Research Institute [G]

[CP] Custom-market Producer
[MP] Mass-market Producer
[DR] Dealer or Rental company
[U] User
[G] General Interest

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ACN EPIs

ANSI E1.17-2006 is the "ESTA Architecture for Control Networks" standard [ACN]. It specifies an architecture – including a suite of protocols and languages which may be configured and combined with other standard protocols in a number of ways to form flexible networked control systems.

E1.17 Profiles for Interoperability (EPIs) are standards documents that specify how conforming implementations are to operate in a particular environment or situation in order to guarantee interoperability. They may specify a single technique, set of parameters or requirement for the various ACN components. They may also specify how other standards (including other EPIs) either defined within ACN or externally are to be used to ensure interoperability.

Abstract

Required techniques for allocation of *IPv4* addresses are specified. These techniques extend EPI13 to allow use of Static IP addresses in controlled circumstances. Some issues and pitfalls are discussed.

Note

This EPI supersedes and obsoletes ACN EPI 13 (Allocation of Internet Protocol Version 4 Addresses to ACN Hosts). The principle reason for this revision is to allow assignment of static IP addresses and provide guidance for how to manage systems using these methods.

1 Introduction

In order to provide "plug and play" interoperability in an *IPv4* system, hosts have to be assigned IP addresses in a manner that is transparent to the inexperienced user, yet which allows flexible configuration in more sophisticated systems.

Many of the systems in which ACN equipment is expected to operate has the special characteristics of short system lifetime (frequent rebuilds of the network into differing systems, often nightly), minimal local user interface, and inaccessibility (equipment may be hung above an audience or built-in beneath a stage). In these conditions it is vital that equipment is always remotely reconfigurable irrespective of its initial configuration state.

This EPI specifies rules for three different standards that operate together to provide reliable automatic assignment of operable addresses to hosts that may be frequently moved between different networks and systems. These standards are Dynamic Host Configuration Protocol [DHCP], Dynamic Configuration of *IPv4 Link-Local* Addresses [IPv4LL] and Detecting Network Attachment in *IPv4* [DHC-DNA]. In addition, restrictions to ensure that inaccessible devices may be reached and conditions under which static IP addresses may be assigned are specified.

While *DHCP* is well established, the other two standards are newly standardized versions of older techniques. Many systems implement something similar to *IPv4LL* but they are often not fully compliant with the standard and will probably work in the majority of cases but may fail in some. *DHC-DNA* is even newer and, while invaluable for equipment that is frequently moved between networks, it is not implemented in any real sense in major operating systems at the time of writing.

2 Levels of Compliance

Since full compliance with the three standards involved is impractical until more implementations are available, this EPI defines three levels of compliance. These are denoted *EPI29-Full*, *EPI29-B* and *EPI29-C*. Separate rules may be specified for compliance to each of the different levels. Rules that do not explicitly state a level of compliance or that simply state "*EPI29*" or "*EPI29-Any*" shall apply for all compliance levels.

3 Future of Level B and C Compliance

Since the initial development of IP, movement of computers between different networks has become far more commonplace and this is a driving force behind such standards as *DHC-DNA*. It is expected that operating systems will increasingly support the full standard. However, levels B and C are currently provided in recognition that many current mainstream operating systems do not fully conform to either *IPv4LL* or *DHC-DNA*. In future revisions of this standard, these permissible compliance levels are likely to be deprecated or removed altogether.

4 Guidance and Reasoning

ACN EPI13 was the original document specifying methods for assigning *IPv4* addresses. The rules of EPI13 are largely reproduced here, and equipment compliant with EPI13 will also be compliant with this EPI. However, it has become clear that there are cases where static IP addressing is required (e.g., by locally enforced network policies) and manufacturers will simply not conform to EPI13, which forbids it.

4.1 Problems With Static IP Addresses

The most serious difficulty with static IP addresses in the ACN context is that once a host is configured with a static IP address, it may become impossible to re-configure it. If a device is inaccessible then reaching a front panel to re-configure it is impractical. Further, if the IP address has been lost (for example in a device returned by a customer to a rental company) methods for remote re-configuration via the network may also be impossible — even ACN discovery may not work. This is the reason that EPI13 forbade static assignment.

Problems with static IP addresses that are commonly recognized and not peculiar to entertainment technology are largely ones of system management not scaling at all well with increasing network size and variability.

4.2 Operating Dynamically Assigned ACN Devices in Static Networks

Even in networks where some or most hosts have static IP addresses, it is possible to operate ACN devices using dynamic assignment to the rules of EPI13 very satisfactorily.

• If a *DHCP* server is available, the easiest way is to configure it to issue addresses from a pool that does not conflict with the static IPs but is in the same subnet.

• If *IPv4LL* addressing is used, there are rules given in the specification [IPv4LL] that indicate how to ensure communication between routable addresses (static or dynamic) and *IPv4LL* addresses on the same network. These are usually fairly simple additions to the routing tables used by the TCP/IP stack. Even in the presence of a *DHCP* server, or with static IP assignment, it is useful to set up these routing rules to ensure that devices that have autoassigned *IPv4LL* addresses can be reached.

• Even in networks where some routable addresses come from different subnets, (e.g., if *DHCP* assigns addresses from a different subnet from the static ones) it is possible to configure routing tables to allow communication.

• In accordance with *IPv4LL*, communication is far less likely to be disrupted and *Link-Local* addressing much more effective if the *IPv4LL* address can be operated at the same time as other addresses (multihoming), at least during transition periods.

5 Rules

5.1 Detecting Network Attachment

The DNA specification [DHC-DNA] discusses issues concerned with detecting changes of network environment and specifies behavior. This is particularly relevant in ACN systems where devices may be moved often and where private addresses [PrivateIP] are commonplace. Many different networks are likely to be running the same private IP address range and a device being moved from one to another needs to detect the fact that its network environment has changed, despite the fact that its IP address may still appear valid (and may even be successfully renewed via DHCP).

Equipment conforming to *EPI29-Full* shall implement Detection of Network Attachment (DNA) in accordance with [DHC-DNA].

Equipment conforming to *EPI29-B* shall take action to detect whether existing IP configurations are valid at network attachment change events.

Equipment conforming to *EPI29-C* should take action to detect whether existing IP configurations are valid at network attachment change events.

Network change events shall include:

• Power on or system reset

• Cable plugged in

• Waking from sleep, suspend or hibernate

• Address conflict detection

5.2 *DHCP* Client

DHCP allows configuration and allocation of fully routable addresses in networks of small devices that do not necessarily have a user interface of their own.

Equipment conforming to *EPI29-Any* shall implement *DHCP* Client functionality for address assignment in accordance with [DHCP].

5.3 *Link-Local* Addressing

Link-Local address allocation [IPv4LL] allows working addresses to be automatically configured in the absence of any servers or centralized control.

Many operating systems including many versions of Apple MacOS and Microsoft Windows implement *Link-Local* address autoallocation schemes that are only partially compliant with the specification. These schemes will work in most cases but do not provide such a rigorous assurance of interoperability, particularly when many of them are mixed together on a network.

Equipment conforming to *EPI29-Full* shall assign *IPv4* Link Local addresses in full compliance with [IPv4LL].

Equipment conforming to *EPI29-B* or EPI29-C should assign *IPv4* Link Local addresses in full compliance with [IPv4LL] but may instead assign *IPv4* Link Local addresses in the 169.254.x.x address space by a compatible scheme as implemented in recognized mainstream operating systems.

5.4 *DHCP* Server

Equipment is not required to implement a *DHCP* server, and a compliant system can function without one, but *DHCP* gives benefits and *DHCP* servers will be found in many systems. However, a *DHCP* server that suddenly appears on a network can cause disruption if it leads to equipment losing functioning addresses (see Change of IP Address below) and this must be preventable.

For example, a controller that includes a *DHCP* server is very likely to be introduced in some systems when they are already functioning — often at a critical time. The operator needs to be in control of when that *DHCP* server becomes active and any ensuing disruption occurs.

To conform to *EPI29-Any*, equipment that provides *DHCP* server functionality on a network shall be configurable to disable that functionality.

5.5 Static Address Configuration

To prevent lockups due to configuration with unknown or unreachable static addresses, equipment that allows static assignment of IP addresses shall allow recovery by one of two methods:

5.5.1 Multihoming

The static IP address shall be operated in parallel with the dynamic assignment algorithm described here by multi-homing. In this case, one or more dynamically assigned address shall be advertised by any discovery mechanism used (e.g., *SLPv2* in accordance with [Discovery-IP]), in addition to any statically assigned address.

5.5.2 Detecting Network Change

The equipment shall take action to detect valid IP configurations as in *EPI29-Full* (preferred) or *EPI29-B* (see Detecting Network Attachment) and on detecting a change of network environment from the one in that the static address was assigned, shall unconfigure its static address and revert to dynamic assignment using *DHCP* or *IPv4LL* as specified elsewhere in this specification. See Section 3, "Future of Level B and C Compliance" regarding probable future compliance requirements.

5.6 BOOTP, RARP

Addresses that are assigned via BOOTP or RARP are not compliant with *EPI29-Any*.

5.7 Choice of Address

To comply with *EPI29-Any,* system implementers/administrators shall not allocate addresses that are reserved, unallocated or otherwise disallowed by *IANA* [IANA] or an appropriate authority delegated by them. They should allocate permitted addresses as assigned by IANA (including by delegated authorities) and where no specific IANA assigned addresses are available, they should either allocate private addresses to create private internets or can allow Link-Local addresses to be assigned by *IPv4LL*.

6 Changes of IP Address

Change of IP address — and particularly loss of an IP address, even if another is substituted — is very disruptive in a working system. Connections that are broken may take time to re-establish and it may not be possible to re-establish them at all. In a control network this can mean sudden loss of control. The kind of networks in which ACN operates, however, are often subject to frequent changes: equipment is turned on and off, moved around and re-configured. Larger controllers, which often implement the network server functions, may also be turned off and on, or replaced. Use of backup controllers to provide security in the event of failure of the primary controller is common. In this environment, implementers must be careful and aware of the issues that can lead to disruption.

6.1 Abandoning an Address

Whether or not for specific reasons discussed here, to comply with *EPI29-Any* a host that ceases using a working IP address shall close any ACN connections using that address in an orderly manner (unless the address has already ceased functioning).

A reason code for this purpose is provided in SDT which indicates that sessions are being closed because of changes in the underlying protocol. This code indicates to other components that they may look for the same service via the discovery mechanism if they need to continue the interaction.

The host must ensure that any services advertised via any discovery mechanism (e.g., *SLPv2, DNS-SD*) using a discontinued address are revoked or changed to reflect a new working address.

In a system implemented according to the rules above, there are a number of reasons why an IP address that is in use may need to be abandoned. The principal ones are given below.

6.2 Loss of DHCP Address: Renewal Fails or Is Refused

This can happen because the *DHCP* server has gone offline and the lease expires or because it refuses a renewal request.

It is usual to attempt renewal well before a lease expires. At this intermediate time being unable to find a *DHCP* server is not sufficient reason to stop using a valid address, but once the expiry time has elapsed, or if the server actively refuses a lease the address must be relinquished after closing connections and deregistering advertisements in accordance with Section 6.1, "Abandoning an Address."

Those implementing or configuring *DHCP* servers should be aware of this and must consider the implications if the server goes offline or changes configuration. Do not re-configure servers so that leases will be refused except when any ensuing loss of connections on the network will do no harm. In general, a server with a stable configuration that is always available is the most satisfactory solution.

6.3 Local Configuration Change

Local changes (e.g., configuring or changing a static address, forcing the release of a lease or other reconfiguration) are beyond the scope of this EPI. Operators should nevertheless be aware that they cannot simply change configuration without potential disruption.

6.4 Link-Local Address Conflict

If equipment properly conforms to the *IPv4LL* specification, loss of address due to conflict will not occur with equipment coming on and off line one host at a time. Large numbers of hosts being powered up at once may give rise to clashes leading to extended time searching for an address, but this should not disrupt equipment that is already functioning unless network conditions lead to loss of lots of packets.

The one time when address conflict leading to re-allocation is probable is when two functioning networks with *Link-Local* addresses are joined. This can happen not just by physical actions such as plugging two switches together, but also due to software actions that bridge networks together.

6.5 Spanning Tree

A particular case to be aware of is spanning-tree networks. The spanning tree algorithm can take sufficiently long that some sectors may already have working *Link-Local* addresses established before the algorithm completes.

6.6 Link-Local to Routable Address Transition

If a host is functioning with a *Link-Local* address and a routable address becomes available (DHCP assigned or static), when and how should the host start using the new address? There are rules and guidelines for this transition in [IPv4LL] that must be followed. The best action that is in accordance with *IPv4LL* is to operate both addresses side by side during a transition period. However, there are IP stacks — particularly some small embedded ones – that cannot operate with multiple addresses.

To comply with *EPI29-Any*, a host that can only support a single address on an interface shall change to a properly assigned routable address that becomes available (subject to any authentication policy present) but should defer the change while any operations known to be critical are in progress using the former address (e.g., while closing down sessions or revoking advertisements).

Note that “advertising” an address as mentioned in *IPv4LL* includes service advertisements via any discovery mechanism (e.g., *SLP, DNS-SD*), therefore to comply with *EPI29-Any* a component with a *Link-Local* address that receives a routable address (e.g., via a *DHCP* server coming online) is required to update its service advertisements to the new address, even if it continues to use the *Link-Local* address as well.

7 Critical Periods

In entertainment technology networks (and many other control networks) there are known critical periods during which disruption of control must be avoided and other times at which some disruption for purposes of re-configuration is quite acceptable. Typically the critical periods are during active processing, for example while a show is running in an entertainment context.

The provisions in this section are guidance and apply to *EPI29-Any*.

7.1 *DHCP* Servers

Equipment incorporating DHCP server functionality should be configurable to set in advance the periods that are critical for control. In many cases this is a case of declaring a daily cycle.

DHCP servers should not issue leases that expire during critical periods. This should be an automatic default policy programmed by the manufacturer rather than left to the user or administrator configuring the server in the field.

DHCP servers that have been off-line or disabled, should not start offering leases during critical periods without explicit confirmation from an operator (with the exception of servers in multi-server systems that are properly synchronized with a functioning DHCP configuration before going live).

DHCP servers should always honor requests for renewal of leases during critical periods unless explicitly instructed by an operator.

DHCP servers should not offer different addresses in response to requests for renewal during a critical periods unless explicitly instructed by an operator.

7.2 Bridging Separate Link-Local Networks Together

System operators and administrators should be aware of the issue of address conflict when *Link-Local* addresses are used if two networks become bridged and of the actions that can cause such bridging. Any such action should be avoided during critical periods.

Equipment designers or programmers must be aware of programmed functions that could lead to bridging of previously separate networks and should not allow such actions to happen during critical periods without explicit instructions.

8 Discovery Considerations

Discovery in this context includes not only the provisions of EPI19 [Discovery-IP] but any other technique used for one ACN component to find others on the network.

To comply with *EPI29-Any* a component shall ensure that it is not advertising services using an address that is no longer functional. It must therefore withdraw or update all services advertised via any discovery mechanism (e.g., by SLP deregistration) that uses the discontinued address.

To comply with [IPv4LL] and *EPI29-Any* any component using an *IPv4 Link-Local* address shall not advertise that address outside the local link. This means that they cannot advertise a *Link-Local* address in any packet that will be sent off link.

Despite this requirement, it is possible that servers or third party hosts used in discovery (e.g., SLP's Directory Agents [SLPv2]) will pass properly advertised *Link-Local* addresses to hosts on other networks. Any host receiving such advertisements (e.g., an SLP User Agent) can guard against this case by checking whether the server is on the same link as itself. When the server is on a different link, the recipient must ignore any advertisement from it that specifies a *Link-Local* address.

In any network — particularly more complex routed ones, a discovery search for ACN components may find ones that are not actually reachable whether because of routing, access policy (firewalls, authentication) or other reasons such as Network Address Translation. The only truly failsafe test is to attempt to connect to it and to check for correct CID (e.g., by attempting to join it to an SDT session).

9 Definitions

IPv4: Internet Protocol version 4.

References

Normative

[ACN] Entertainment Services and Technology Association [http://www.esta.org/tsp/]. ANSI E1.17-2006. *Entertainment Technology - Architecture for Control Networks*. 2006-10-19.

[AddrIPv4] Entertainment Services and Technology Association [http://www.esta.org/tsp/]. ESTA TSP CP/2004-1024R2. *Entertainment Technology - Architecture for Control Networks. EPI 13. Allocation of Internet Protocol Version 4 Addresses to E1.17 hosts*. 2006-10-19.

[DHCP] Internet Engineering Task Force (IETF) [http://ietf.org/]. RFC 2131 [http://ietf.org/rfc/rfc2131.txt]. R. Droms. *Dynamic Host Configuration Protocol*. 1997.

[Discovery-IP] Entertainment Services and Technology Association [http://www.esta.org/tsp/]. ESTA TSP CP/2003-1012R3. *Entertainment Technology - Architecture for Control Networks. EPI 19. Discovery on IP networks*. 2006-10-19.

[DHC-DNA] Internet Engineering Task Force (IETF) [http://ietf.org/]. RFC4436 [http://ietf.org/rfc/rfc4436.txt]. B. Aboba, J. Carlson, and S. Cheshire. *Detecting Network Attachment in IPv4 (DNAv4)*. March 2006.

[IPv4LL] Internet Engineering Task Force (IETF) [http://ietf.org/]. RFC3927 [http://ietf.org/rfc/rfc3927.txt]. Stuart Cheshire, Bernard Aboba, and Erik Guttman. *Dynamic Configuration of IPv4 Link-Local Addresses*. 2005.

[PrivateIP] Internet Engineering Task Force (IETF) [http://ietf.org/]. RFC 1918 [http://ietf.org/rfc/rfc1918.txt]. Y. Rekhter, B. Moskowitz, D. Karrenberg, J. de Groot, and E. Lear. *Address Allocation for Private Internets*. 1996.

[SLPv2] Internet Engineering Task Force (IETF) [http://ietf.org/]. RFC 2608 [http://ietf.org/rfc/rfc2608.txt]. Guttman, Perkins, Veizades, and Day. *Service Location Protocol, Version 2*. 1999.

[IANA] Internet Assigned Numbers Authority [http://iana.org/]. http://iana.org/assignments/ipv4-address-space. *IPv4 Global Unicast Address Assignments*.

Informative

[DNS-SD] Internet Engineering Task Force (IETF) [http://ietf.org/]. draft-cheshire-dnsext-dns-sd-04.txt [http://files.dns-sd.org/draft-cheshire-dnsext-dns-sd.txt]. Stuart Cheshire and Mark Krochmal. *Internet Draft: DNS-Based Service Discovery*. 2007.