

VOICEBOOTCAMP DESIGN ARCHITECT SERIES

Unified CM 15

Collaboration Design Scenario Question Bank

60 product-documentation-based architecture decisions with answers and design rationale

Northbridge Global Manufacturing

Fictional enterprise case study | Instructor edition

Company scenario

Northbridge Global Manufacturing (NGM) is a fictional multinational manufacturer with 24,000 employees across North America, Europe, and Asia-Pacific. It operates headquarters and regional data centers, 32 plants and offices, and a mixed population of Cisco desk phones, Jabber clients, and video endpoints. NGM is designing an on-premises Cisco Collaboration 15 architecture while upgrading acquired Unified CM environments to Release 15.

Design area	NGM requirement
Availability	Survive a single application-node or edge-device failure; provide appropriate branch survivability.
Call control	Centralized where practical, regionalized where latency or administration requires; global numeric and URI dialing.
Conferencing	Ad hoc, persistent, and scheduled on-premises audio/video meetings.
Edge	MRA for remote users, B2B video, and secure SIP service-provider connectivity.
Messaging	Highly available Unity Connection with centralized identity management.
Security	Trusted certificates, encrypted communications, restrictive PSTN access, and segmented networks.
WAN	Protect audio, classify video, and prevent oversubscription on constrained plant links.
Migration	Move eligible 12.5 systems and legacy acquired clusters to Release 15 with validated rollback.

Question method: Act as NGM's lead Collaboration architect. For each scenario, select the product, feature, topology, or migration method that best satisfies the stated requirement. One best answer applies unless explicitly stated otherwise.

Documentation boundary

The questions are original training content derived from the two supplied Cisco documents: Preferred Architecture for Cisco Collaboration Release 15 On-Premises Deployments, Design Overview; and Upgrade and Migration Guide for Cisco Unified Communications Manager and the IM and Presence Service, Release 15 and SUs. The questions do not test the CCIE exam-format announcement.

Question distribution

- **Enterprise Architecture and Endpoint Strategy:** 3 questions
- **Unified CM Clustering, Dial Plan, and Multi-Cluster Design:** 15 questions
- **Conferencing Architecture:** 5 questions
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Enterprise Architecture and Endpoint Strategy

Northbridge architecture decisions: 3 questions

DESIGN DECISION 01 | ENTERPRISE ARCHITECTURE AND ENDPOINT STRATEGY**Architect scenario**

Northbridge Global Manufacturing (NGM) has 24,000 employees and requires the majority of calling, messaging, conferencing, and management services to remain in its own data centers. Limited cloud connectivity for licensing, push notifications, and operational analytics is permitted.

Which architectural baseline should the design team use?

- A. Cisco Collaboration 15 on-premises Preferred Architecture
- B. A Webex Calling-only architecture with no on-premises applications
- C. A consumer SIP service connected directly to every endpoint
- D. An air-gapped architecture that prohibits every Cisco cloud dependency

Architect's selection: A

Design rationale

The on-premises Preferred Architecture is intended for enterprise deployments of more than 1,000 users where most applications are delivered on-premises. It does not prohibit selected cloud services such as push notifications, Smart Software Licensing, or Cloud-Connected UC. Therefore it matches NGM's stated operating model better than a cloud-only or fully air-gapped design.

Source basis: Design Collaboration 15, pp. 4-7

DESIGN DECISION 02 | ENTERPRISE ARCHITECTURE AND ENDPOINT STRATEGY**Architect scenario**

NGM's executive sponsor requires the collaboration service to remain available after a single application-node failure. The initial bill of materials contains only one instance of each core application.

What should the architect change?

- A. Keep one instance and rely only on nightly backups
- B. Deploy redundant components and use the clustering mechanisms of the applications
- C. Add a second WAN carrier but keep every application single-node
- D. Place all applications on one larger virtual machine

Architect's selection: B

Design rationale

The Preferred Architecture recommends redundant components and configurations. Application clustering replicates configuration to backup instances and allows services such as endpoint registration, calls, conferencing, and messaging to continue when an application instance fails. Backups do not provide immediate service continuity.

Source basis: Design Collaboration 15, pp. 9-10

DESIGN DECISION 03 | ENTERPRISE ARCHITECTURE AND ENDPOINT STRATEGY**Architect scenario**

A 180-user NGM plant uses Cisco desk phones and depends on centralized Unified CM. The WAN has experienced several multi-hour outages, but the plant has a local PSTN circuit on its ISR.

Which feature should the engineer select to preserve essential local calling during a WAN failure?

- A. Survivable Remote Site Telephony on the ISR
- B. Global Dial Plan Replication
- C. Webex Cloud-Connected UC
- D. Cisco Meeting Management

Architect's selection: A

Design rationale

SRST provides backup call control at a remote site when endpoints cannot register to centralized Unified CM. With local PSTN access, the site can retain internal point-to-point voice calls, external PSTN calls, hold, transfer, conference, and music on hold during the WAN outage.

Source basis: Design Collaboration 15, pp. 10, 13, and 17-18

Unified CM Clustering, Dial Plan, and Multi-Cluster Design

Northbridge architecture decisions: 15 questions

DESIGN DECISION 04 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM initially operates from one headquarters and 14 remote offices. The latency from every office to the primary data centers is within design limits, and no department requires separate administration.

What is the recommended starting call-control design?

- A. One Unified CM cluster serving the central and remote sites
- B. One Unified CM cluster per branch regardless of size
- C. No call-control cluster; use independent gateways
- D. One Unity Connection cluster as the call-control platform

Architect's selection: A

Design rationale

The Preferred Architecture recommends a single Unified CM cluster for an enterprise with a central site and remote offices, with call-processing subscribers deployed in pairs for scale and redundancy. Additional clusters are introduced when scale, geography, or organizational separation requires them.

Source basis: Design Collaboration 15, pp. 15-16

DESIGN DECISION 05 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM acquires an Asian subsidiary. Propagation delay makes registration to the North American Unified CM cluster unsuitable, and the subsidiary requires local operational control.

Which design change is most appropriate?

- A. Add a regional Unified CM cluster
- B. Add only another TFTP node to the North American cluster
- C. Use a CSS to eliminate WAN delay
- D. Replace SIP with HTTP

Architect's selection: A

Design rationale

The document identifies geographic footprint, excessive propagation delay, and administrative separation as reasons to deploy more than one Unified CM and IM and Presence cluster. A regional cluster directly addresses both latency and administration requirements.

Source basis: Design Collaboration 15, p. 20

DESIGN DECISION 06 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

The Unified CM design currently places four call-processing subscribers in a single unpaired pool. NGM requires 1:1 redundancy and predictable endpoint failover.

How should the subscribers be organized?

- A. As call-processing subscriber pairs
- B. As four independent publishers
- C. As TFTP-only servers
- D. As an Expressway cluster

Architect's selection: A

Design rationale

Call-processing subscribers should be deployed in pairs to provide 1:1 redundancy. Endpoints can use the paired nodes for registration and call processing, reducing the impact of a subscriber failure.

Source basis: Design Collaboration 15, pp. 16-17

DESIGN DECISION 07 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM wants both members of each subscriber pair to carry production registrations during normal operation while still backing up one another.

Which redundancy model should the architect select?

- A. Active/active subscriber-pair redundancy
- B. Publisher-only call processing
- C. Cold standby with both subscribers normally stopped
- D. DNS round robin without Unified CM groups

Architect's selection: A

Design rationale

The Preferred Architecture recommends active/active redundancy for each call-processing subscriber pair. This load-balances call processing in normal operation and reduces failover response time.

Source basis: Design Collaboration 15, p. 17

DESIGN DECISION 08 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

During a subscriber outage, phones fail over correctly, but the design has only one TFTP node and therefore retains a configuration-distribution single point of failure.

What should be added?

- A. A paired TFTP node
- B. A second publisher in the same cluster
- C. A CMS scheduler
- D. A second LDAP directory solely for firmware

Architect's selection: A

Design rationale

The design guidance calls for both call-processing subscribers and TFTP nodes to be deployed in pairs for 1:1 redundancy. TFTP nodes distribute endpoint configuration and firmware, so subscriber redundancy does not remove the TFTP single point of failure.

Source basis: Design Collaboration 15, p. 16

DESIGN DECISION 09 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM enables enterprise instant messaging and presence. The proposed design contains only one IM and Presence publisher.

What is the minimum recommended highly available design?

- A. One IM and Presence publisher and one subscriber
- B. Two IM and Presence publishers in the same cluster
- C. One Unified CM TFTP node only
- D. One Expressway-E only

Architect's selection: A

Design rationale

The recommended minimum is one IM and Presence publisher and one subscriber. The IM and Presence publisher is not a dedicated node; the publisher and subscriber provide redundancy for each other. Additional pairs can be added for enterprise scale.

Source basis: Design Collaboration 15, pp. 16-17

DESIGN DECISION 10 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM must connect Unified CM to Unity Connection, Cisco Meeting Server, CUBE, Expressway, and a third-party recording platform using a consistent standards-based protocol.

Which connectivity method should the architect standardize on?

- A. SIP trunks
- B. H.323 gatekeeper zones only
- C. HTTP route patterns
- D. TFTP interapplication trunks

Architect's selection: A

Design rationale

SIP trunks are recommended between Unified CM and components in the on-premises Preferred Architecture, including external third-party systems. They provide a standards-based environment, reduce operational complexity, carry presence information, and are recommended for video communications.

Source basis: Design Collaboration 15, pp. 17-18

DESIGN DECISION 11 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

A 20-user NGM sales office has no local PSTN circuit. Its WAN reliability exceeds the business service-level requirement, and management does not require local call survival.

Based on the Preferred Architecture guidance, what is the most defensible SRST decision?

- A. SRST is not required by the stated design criteria
- B. SRST is mandatory at every remote office
- C. SRST must run on Expressway-E
- D. SRST must be supplied by Unity Connection

Architect's selection: A

Design rationale

The guidance calls for SRST when a remote site has local PSTN or when it has more than 25 users without local PSTN, subject to the site's availability requirement. This site has neither trigger and its WAN meets the required service level, so the architect can document why SRST is not required.

Source basis: Design Collaboration 15, pp. 17-18

DESIGN DECISION 12 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

A 70-user NGM engineering branch has no local PSTN, but users require internal calling continuity when the WAN is unavailable.

Which design choice follows the Preferred Architecture recommendation?

- A. Deploy SRST on the branch ISR
- B. Deploy GDPR on the branch switch
- C. Deploy CMS Spaces for survivability
- D. Use only a second DHCP server

Architect's selection: A

Design rationale

The guide recommends SRST for a remote site without local PSTN when it has more than 25 users. SRST supplies backup call control; without local PSTN, external PSTN continuity is not implied.

Source basis: Design Collaboration 15, pp. 17-18

DESIGN DECISION 13 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM wants a global number plan that simplifies caller-ID presentation, directory lookups, on-net routing, and PSTN failover without maintaining a separate proprietary numbering scheme.

What should be used as the primary numeric endpoint address format?

- A. +E.164
- B. Random four-digit extensions only
- C. SIP IP addresses
- D. MAC addresses

Architect's selection: A

Design rationale

+E.164 numbers with a leading plus sign are recommended as endpoint addresses. They are widely used, simplify caller-ID presentation and directory lookups, and support straightforward alternate routing to the PSTN.

Source basis: Design Collaboration 15, pp. 18-19

DESIGN DECISION 14 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

Users still require four-digit intra-site dialing and an abbreviated inter-site dialing habit, although all directory numbers are stored as +E.164 addresses.

How should the architect implement the abbreviated habits?

- A. Use translation patterns to normalize them to +E.164
- B. Replace every +E.164 directory number with four digits
- C. Build a separate cluster for each dialing habit
- D. Send abbreviated calls directly to the PSTN without normalization

Architect's selection: A

Design rationale

The design uses +E.164 as the global routing address and implements other numeric dialing habits as overlays. Translation patterns map abbreviated inputs to +E.164, allowing multiple user dialing habits without compromising the global route plan.

Source basis: Design Collaboration 15, p. 19

DESIGN DECISION 15 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM deploys Jabber and wants users to search the corporate directory and authenticate with their enterprise directory credentials from one centrally managed identity source.

Which integration is required?

- A. LDAP integration with Unified CM
- B. A local Unified CM account manually created for every user
- C. DNS SRV records only
- D. A CMS call bridge group

Architect's selection: A

Design rationale

LDAP integration provides centralized directory management and authentication for Unified CM and Jabber. Unified CM synchronizes attributes such as name, username, telephone number, and SIP URI, while IM and Presence obtains the user information from Unified CM.

Source basis: Design Collaboration 15, pp. 19-20

DESIGN DECISION 16 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

Lobby phones must dial only emergency and local numbers, standard employees may dial national numbers, and executives may dial internationally.

Which Unified CM design constructs should enforce these classes of service?

- A. Partitions and calling search spaces
- B. Device pools and regions only
- C. LDAP filters only
- D. TFTP server order

Architect's selection: A

Design rationale

Partitions and calling search spaces define which destinations a calling device or line can reach. They are the core Unified CM constructs for differentiated classes of service and are therefore the correct control for the lobby, employee, and executive policies.

Source basis: Design Collaboration 15, p. 20

DESIGN DECISION 17 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

NGM's growth plan creates five Unified CM clusters. The network team wants to avoid a full mesh of intercluster SIP trunks and centralize dial-plan and trunk management.

Which component should the architect introduce?

- A. Unified CM Session Management Edition
- B. A second Unity Connection publisher
- C. Local Push Notification Service
- D. A standalone TFTP server

Architect's selection: A

Design rationale

For four or more Unified CM clusters, the Preferred Architecture recommends Session Management Edition to centralize the dial plan and trunking and avoid the complexity of a full-mesh SIP-trunk topology.

Source basis: Design Collaboration 15, p. 20

DESIGN DECISION 18 | UNIFIED CM CLUSTERING, DIAL PLAN, AND MULTI-CLUSTER DESIGN**Architect scenario**

Users in different NGM clusters must reach one another deterministically by +E.164 number, enterprise significant number, URI, and PSTN-normalized number.

Which feature should distribute the dial-plan reachability information?

- A. Global Dial Plan Replication
- B. Survivable Remote Site Telephony
- C. Cisco TFTP
- D. Local Route Group only

Architect's selection: A

Design rationale

GDPR replicates dial-plan information among clusters. It can advertise a +E.164 number, one ESN, and up to five alphanumeric URIs per directory number, enabling deterministic intercluster routing for the specified dialing habits.

Source basis: Design Collaboration 15, p. 20

Conferencing Architecture

Northbridge architecture decisions: 5 questions

DESIGN DECISION 19 | CONFERENCING ARCHITECTURE

Architect scenario

NGM requires ad hoc, permanent, and scheduled audio/video conferences under the on-premises Collaboration 15 architecture.

Which conferencing platform should the architect select for all three conference types?

- A. Cisco Meeting Server
- B. Unity Connection
- C. Expressway-E
- D. Unified CM TFTP

Architect's selection: A

Design rationale

The Preferred Architecture recommends Cisco Meeting Server for instant or ad hoc, permanent or rendezvous, and scheduled conferences. Other listed components do not provide the complete conferencing role.

Source basis: Design Collaboration 15, pp. 22-23

DESIGN DECISION 20 | CONFERENCING ARCHITECTURE**Architect scenario**

A user on Unified CM starts a two-party call and presses Conference to add more participants. NGM wants CMS to supply the media resource for this instant conference.

How should CMS be integrated for this use case?

- A. SIP trunks plus registered media-resource conference bridges
- B. LDAP only
- C. A PSTN route list only
- D. Expressway DNS zones only

Architect's selection: A

Design rationale

For instant conferences, the CMS cluster is integrated with Unified CM through SIP trunks and registered conference-bridge media resources. Unified CM uses HTTPS for conference control and SIP for call signaling to the CMS conference bridges.

Source basis: Design Collaboration 15, pp. 23-24

DESIGN DECISION 21 | CONFERENCING ARCHITECTURE**Architect scenario**

NGM creates permanent meeting rooms that users reach through a stable number or URI.

Which CMS construct should provide the persistent meeting room?

- A. CMS Space
- B. Unified CM device pool
- C. Expressway traversal zone
- D. Unity Connection call handler

Architect's selection: A

Design rationale

A CMS Space is a persistent virtual meeting room that supports video, voice, and content sharing. It can be assigned a video-address URI or numeric alias and provisioned through the CMS web interface, API, or Cisco Meeting Management.

Source basis: Design Collaboration 15, p. 24

DESIGN DECISION 22 | CONFERENCING ARCHITECTURE**Architect scenario**

The dial plan must route permanent and scheduled conference numbers from Unified CM to CMS.

Which integration objects should the engineer use?

- A. SIP trunks and route patterns
- B. TFTP alternate file locations
- C. CSSM virtual accounts
- D. SRST reference groups

Architect's selection: A

Design rationale

The Preferred Architecture integrates permanent and scheduled CMS conferences with Unified CM through SIP trunks and route patterns. Registered conference bridges are associated with the instant-conference use case.

Source basis: Design Collaboration 15, pp. 23-24

DESIGN DECISION 23 | CONFERENCING ARCHITECTURE**Architect scenario**

NGM has three Unified CM clusters in three data centers. Users must dial the same conference address regardless of their home cluster, while media resources should remain close to the corresponding call-processing region.

Which design best meets both requirements?

- A. One CMS cluster with a call bridge group dedicated to each Unified CM cluster and colocated call bridges
- B. A different unrelated conference URI on every Unified CM cluster
- C. One standalone call bridge in a fourth distant data center
- D. Separate Unity Connection clusters used as conference bridges

Architect's selection: A

Design rationale

For multiple Unified CM clusters, the design recommends a single CMS cluster with one call bridge group per Unified CM cluster. Call bridges in each group should be in the same data center as the corresponding Unified CM cluster, while the single CMS cluster preserves a common conference address.

Source basis: Design Collaboration 15, pp. 24-25

Collaboration Edge, Remote Access, and PSTN

Northbridge architecture decisions: 6 questions

DESIGN DECISION 24 | COLLABORATION EDGE, REMOTE ACCESS, AND PSTN**Architect scenario**

NGM requires secure Mobile and Remote Access for Jabber and supported video endpoints without a user VPN.

Which edge components should be deployed?

- A. Expressway-C and Expressway-E
- B. Unity Connection publisher and subscriber
- C. CMS web scheduler and LDAP
- D. TFTP and DHCP only

Architect's selection: A

Design rationale

Expressway provides secure firewall and NAT traversal for remote Jabber and supported TelePresence endpoints. Expressway-C operates inside the trusted network and establishes the secure traversal connection to Expressway-E in the DMZ.

Source basis: Design Collaboration 15, pp. 26-28

DESIGN DECISION 25 | COLLABORATION EDGE, REMOTE ACCESS, AND PSTN**Architect scenario**

The security team wants Internet-facing traversal services isolated from the trusted collaboration network.

Where should the architect place the Expressway roles?

- A. Expressway-C in the trusted network and Expressway-E in the DMZ
- B. Both servers directly on the public Internet
- C. Expressway-E inside the trusted voice VLAN and Expressway-C in the DMZ
- D. Both servers on the endpoint access VLAN

Architect's selection: A

Design rationale

Expressway-C belongs in the trusted internal network. Expressway-E is reachable from the untrusted external network and should be placed in the DMZ, with firewall policies controlling communications to and from it.

Source basis: Design Collaboration 15, pp. 28-29

DESIGN DECISION 26 | COLLABORATION EDGE, REMOTE ACCESS, AND PSTN**Architect scenario**

NGM expects high MRA usage and high-volume business-to-business video. Security policy also requires operational separation between remote registration and B2B traversal.

Which Expressway topology is recommended?

- A. Separate clustered Expressway-C/E pairs for MRA and for B2B
- B. One standalone Expressway-E for every service
- C. Expressway-C only with no Expressway-E
- D. CUBE alone for Jabber MRA

Architect's selection: A

Design rationale

The Preferred Architecture recommends separate Expressway-C/E pairs for remote registration/MRA and secure B2B connectivity, with clustering for scale and redundancy. A shared cluster may be considered only when utilization does not justify separate clusters and policy permits it.

Source basis: Design Collaboration 15, pp. 27-28

DESIGN DECISION 27 | COLLABORATION EDGE, REMOTE ACCESS, AND PSTN**Architect scenario**

External partners must call NGM video URIs over the Internet, and NGM must discover external destinations by domain.

Which Expressway-E capability supports this design?

- A. DNS SRV lookup for inbound and outbound Internet calls
- B. TFTP firmware distribution
- C. Local Push Notification Service
- D. Unity Connection alternate extensions

Architect's selection: A

Design rationale

Expressway-E provides DNS SRV lookup to resolve outbound calls and receive inbound calls over the Internet. It then passes secure traversal traffic to Expressway-C.

Source basis: Design Collaboration 15, p. 29

DESIGN DECISION 28 | COLLABORATION EDGE, REMOTE ACCESS, AND PSTN**Architect scenario**

NGM purchases SIP trunking from a service provider. The provider connection must be terminated and protected at the enterprise edge before calls reach Unified CM.

Which function should be enabled on the supported edge router?

- A. Cisco Unified Border Element
- B. Cisco TFTP
- C. Global Dial Plan Replication
- D. Cisco Meeting Server web bridge

Architect's selection: A

Design rationale

When SIP trunks connect to a voice service provider, the design enables CUBE on the supported Catalyst 8000 or ISR platform. CUBE provides the session-border function and supports edge security and interworking.

Source basis: Design Collaboration 15, pp. 29-30

DESIGN DECISION 29 | COLLABORATION EDGE, REMOTE ACCESS, AND PSTN**Architect scenario**

A single CUBE or Expressway server failure must not interrupt NGM's external calling and traversal services.

Which redundancy design is recommended?

- A. CUBE routers in active/standby pairs and Expressway-C/E in clustered multiple pairs
- B. One CUBE with a larger power supply and one Expressway-E
- C. DNS round robin to one server
- D. A Unity Connection cluster used as an SBC

Architect's selection: A

Design rationale

For full redundancy, the guidance recommends Catalyst 8000/ISR CUBE platforms in active/standby pairs and Expressway-C/E servers in clusters with multiple pairs. Increasing the size of a single node does not remove the single point of failure.

Source basis: Design Collaboration 15, pp. 27-30

Voice Messaging, Operations, and Licensing

Northbridge architecture decisions: 6 questions

DESIGN DECISION 30 | VOICE MESSAGING, OPERATIONS, AND LICENSING**Architect scenario**

NGM requires highly available on-premises voicemail. The proposed Unity Connection design has one server with enough ports for normal traffic but no failover capacity.

Which architecture should replace it?

- A. A two-node Unity Connection active/active cluster
- B. Four Unity Connection publishers
- C. One CMS cluster
- D. One Expressway-C/E pair

Architect's selection: A

Design rationale

A Unity Connection cluster contains a maximum of two nodes, one publisher and one subscriber, operating active/active for availability and redundancy. Either node can handle the cluster workload when the other fails.

Source basis: Design Collaboration 15, pp. 31-32

DESIGN DECISION 31 | VOICE MESSAGING, OPERATIONS, AND LICENSING**Architect scenario**

During failure testing, the surviving Unity Connection node exhausts its voicemail ports even though the two-node cluster had enough aggregate ports during normal operation.

What design correction is required?

- A. Size each Unity Connection server with enough ports for all cluster calls
- B. Add a third Unity Connection node
- C. Move voicemail ports to Expressway-E
- D. Disable SIP integration

Architect's selection: A

Design rationale

Because either active node must handle all calls and HTTP requests after the peer fails, each Unity Connection server must have enough voicemail ports for the complete cluster workload. A third node is not supported in the two-node cluster model.

Source basis: Design Collaboration 15, p. 32

DESIGN DECISION 32 | VOICE MESSAGING, OPERATIONS, AND LICENSING**Architect scenario**

NGM integrates a two-node Unity Connection cluster with one Unified CM cluster and wants call signaling to survive the loss of either voicemail node.

How should the SIP integration be designed?

- A. Configure two SIP trunks, one to each Unity Connection node
- B. Configure one SIP trunk to the publisher only
- C. Use an HTTP connection instead of SIP
- D. Register Unity Connection as an IP phone

Architect's selection: A

Design rationale

The recommended integration uses SIP and configures two SIP trunks from Unified CM, one for each Unity Connection server. This aligns signaling connectivity with the two-node availability model.

Source basis: Design Collaboration 15, pp. 32-33

DESIGN DECISION 33 | VOICE MESSAGING, OPERATIONS, AND LICENSING**Architect scenario**

NGM wants centralized user administration for voicemail. Some users have +E.164 numbers and require alternate extensions for legacy dialing habits.

Which Unity Connection provisioning approach should the architect select?

- A. Import users from enterprise LDAP, assign a unique voicemail number, and use supported alternate extensions
- B. Share one voicemail number among all users
- C. Provision users only through Expressway-E
- D. Replace every +E.164 number with an IP address

Architect's selection: A

Design rationale

Unity Connection can import users from enterprise LDAP. Each mailbox needs a unique voicemail number; E.164 and +E.164 formats are supported, along with alternate extensions where required.

Source basis: Design Collaboration 15, pp. 32-33

DESIGN DECISION 34 | VOICE MESSAGING, OPERATIONS, AND LICENSING**Architect scenario**

NGM operates multiple on-premises Unified CM and Unity Connection clusters. Operations wants one cloud-based interface for analytics, certificates, operational status, and troubleshooting while retaining on-premises calling.

Which service should the architect recommend?

- A. Webex Cloud-Connected UC
- B. Local Push Notification Service
- C. SRST
- D. CMS Spaces

Architect's selection: A

Design rationale

Cloud-Connected UC is designed for customers retaining on-premises Unified CM while centralizing selected operational tasks in Control Hub. It includes analytics, certificate management, operational views, and troubleshooting capabilities across clusters and UC applications.

Source basis: Design Collaboration 15, pp. 36-38

DESIGN DECISION 35 | VOICE MESSAGING, OPERATIONS, AND LICENSING**Architect scenario**

NGM permits outbound HTTPS through a corporate proxy and wants centralized license usage and entitlement management for Unified CM, Unity Connection, CMS, and Expressway.

Which licensing design is recommended?

- A. Direct or proxied communication with Cisco Smart Software Manager
- B. Store license files on TFTP only
- C. Use GDPR for license pooling
- D. Use CMS Spaces as a license server

Architect's selection: A

Design rationale

Cisco Smart Software Manager centralizes license management and supports flexible license pooling across nodes and clusters. The Preferred Architecture recommends direct or proxy communication from on-premises publisher nodes when Internet connectivity is permitted.

Source basis: Design Collaboration 15, pp. 39-40

Security and Bandwidth Management

Northbridge architecture decisions: 9 questions

DESIGN DECISION 36 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

NGM has thousands of endpoints and applications. Administrators are manually importing self-signed Tomcat and XMPP certificates into many client trust stores, creating operational risk.

Which certificate strategy should the architect select?

- A. Use certificates signed by a trusted certificate authority
- B. Continue distributing every self-signed certificate manually
- C. Disable certificate validation
- D. Replace TLS with unencrypted HTTP

Architect's selection: A

Design rationale

CA-signed certificates scale better because clients can trust the issuing CA rather than every individual self-signed certificate. This is especially important for Unified CM, IM and Presence, and Unity Connection Tomcat certificates and the IM and Presence XMPP certificate.

Source basis: Design Collaboration 15, pp. 42-43

DESIGN DECISION 37 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

NGM's Internet-facing Expressway-E must present a certificate that external organizations can validate without importing NGM's private CA.

Which certificate should be used?

- A. A certificate signed by a public CA
- B. A self-signed certificate accepted manually by every partner
- C. A phone MIC
- D. An unsigned certificate

Architect's selection: A

Design rationale

The Preferred Architecture specifically recommends public-CA-signed certificates for Expressway-E. Public trust is essential for scalable B2B and external traversal relationships.

Source basis: Design Collaboration 15, p. 43

DESIGN DECISION 38 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

NGM will encrypt signaling and media for supported desk phones and can issue endpoint identity certificates from its Unified CM certificate authority function.

Which endpoint certificate is preferred when possible?

- A. Local Significant Certificate
- B. Manufacturer Installed Certificate only
- C. Expressway-E server certificate
- D. LDAP server certificate

Architect's selection: A

Design rationale

Both MICs and LSCs can participate in endpoint security, but the design guidance recommends using an LSC instead of a MIC whenever possible. Endpoint certificates support signaling/media encryption, phone web security, and optional encrypted configuration files.

Source basis: Design Collaboration 15, p. 43

DESIGN DECISION 39 | SECURITY AND BANDWIDTH MANAGEMENT

Architect scenario

NGM currently synchronizes users over TCP 389. Security policy now requires encrypted LDAP or Global Catalog access.

Which ports should the architect specify?

- A. 636 or 3269
- B. 389 or 3268
- C. 22 only
- D. 5060 only

Architect's selection: A

Design rationale

The Preferred Architecture recommends secure LDAP connections on 636 or secure Global Catalog connections on 3269 instead of the non-secure 389 and 3268 alternatives.

Source basis: Design Collaboration 15, pp. 43-44

DESIGN DECISION 40 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

Inbound PSTN calls to NGM must never be able to hairpin back to unrestricted international PSTN routes. Lobby phones also require the most restrictive calling privileges.

Which Unified CM controls best address the requirement?

- A. Restrictive partitions/CSS and the Block OffNet to OffNet Transfer parameter
- B. A larger region bandwidth value
- C. A second TFTP server
- D. CMS call bridge groups

Architect's selection: A

Design rationale

Partitions and CSS enforce the most restrictive class of service, including preventing calls arriving from the PSTN from reaching PSTN routes. Block OffNet to OffNet Transfer is an additional toll-fraud control; time-of-day routing, FACs, and route filters can add further restrictions.

Source basis: Design Collaboration 15, pp. 42-43

DESIGN DECISION 41 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

NGM wants encrypted signaling, media, and phone configuration delivery for modern endpoints without enabling cluster-wide mixed mode solely for those endpoints.

Which mechanism should be preferred where endpoints support it?

- A. SIP OAuth
- B. Plain SIP over TCP
- C. HTTP directory access
- D. Unencrypted TFTP

Architect's selection: A

Design rationale

The Preferred Architecture recommends SIP OAuth for supported endpoints to enable encrypted call signaling, media, and IP phone configuration files. Mixed mode remains the alternative when SIP OAuth is unavailable or unsupported for part of the endpoint population.

Source basis: Design Collaboration 15, pp. 42-44

DESIGN DECISION 42 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

A congested WAN must protect the intelligibility of every audio stream, including the audio component of video calls.

How should that audio be marked at the access edge?

- A. Expedited Forwarding (EF)
- B. AF42
- C. Best effort
- D. Scavenger class

Architect's selection: A

Design rationale

The bandwidth-management recommendation marks all audio as EF, including audio-only calls and the audio stream of video calls. This protects audio from loss experienced in video queues and preserves an uninterrupted audio experience during congestion.

Source basis: Design Collaboration 15, pp. 45-47

DESIGN DECISION 43 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

NGM wants critical room-system video to receive higher treatment while Jabber, MRA, and Edge video use bandwidth opportunistically and throttle more aggressively during congestion.

Which marking design should be selected?

- A. AF41 for critical room/desktop video and AF42 for Jabber, MRA, and Edge video
- B. EF for all video and best effort for audio
- C. AF42 for critical rooms and AF41 for all opportunistic video
- D. Best effort for every collaboration flow

Architect's selection: A

Design rationale

The Preferred Architecture recommends AF41 for critical desktop and room video and AF42 for Jabber, MRA, and Edge video. AF42 creates the opportunistic class; if AF42 cannot be supported, AF41 may be used for all video, but the opportunistic-video benefit is reduced.

Source basis: Design Collaboration 15, p. 47

DESIGN DECISION 44 | SECURITY AND BANDWIDTH MANAGEMENT**Architect scenario**

Only the WAN links to NGM's small plants have restricted bandwidth. Campus LANs and data-center links are sufficiently provisioned.

Where should call admission control limits be applied?

- A. Use Enhanced Locations CAC only where bandwidth is restricted
- B. Reject calls on every network segment equally
- C. Use CSS instead of CAC to measure bandwidth
- D. Use TFTP load balancing as CAC

Architect's selection: A

Design rationale

The design guidance recommends Enhanced Locations Call Admission Control and limiting calls only in areas where bandwidth resources are restricted. This prevents oversubscription without unnecessarily limiting calls on unconstrained segments.

Source basis: Design Collaboration 15, pp. 45-47

Release 15 Upgrade and Migration Architecture

Northbridge architecture decisions: 16 questions

DESIGN DECISION 45 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

NGM's main cluster runs Unified CM and IM and Presence 12.5 on supported ESXi. The target is Release 15, and the team wants to change only the application version while retaining the existing deployment identity.

Which upgrade method is the primary candidate, assuming the supported-path table and readiness checks confirm eligibility?

- A. Direct standard upgrade
- B. Direct refresh upgrade
- C. Legacy bridge upgrade through every intermediate release
- D. Rebuild as Unity Connection

Architect's selection: A

Design rationale

The guide lists a supported direct upgrade path from 12.5 to 15 using Unified OS Administration/CLI or PCD Upgrade, subject to COP and platform requirements. Release 15 has no Direct Refresh Upgrade paths. Release 15 VM settings still have to be updated to the destination requirements.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 4 and 8-18

DESIGN DECISION 46 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

The 12.5 virtual machines were originally installed with a single 80-GB virtual disk. An engineer manually expanded the disk to 110 GB and now proposes a direct upgrade to Release 15.

What should the architect decide?

- A. Reject the plan; use backup/restore to a correctly built 110-GB VM or a supported migration method
- B. Approve because manually expanding the disk makes it equivalent to a Release 15 install
- C. Reduce the disk to 80 GB before upgrading
- D. Ignore the disk and add RAM only

Architect's selection: A

Design rationale

Release 15 supports a minimum 110-GB virtual disk at install time, and the guide states that a direct upgrade fails for single 80-GB-vDisk deployments even if the disk was manually resized to 110 GB. The supported design is to move the data to a correctly deployed VM or use a supported PCD migration approach.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 2 and 20-22

DESIGN DECISION 47 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

An acquired NGM cluster runs Release 11.5. The destination is Release 15, and the supported-path table does not offer a direct standard upgrade.

Which migration choices should the architect evaluate?

- A. PCD 15 Migration Task or Fresh Install with Data Import
- B. Direct Refresh Upgrade
- C. A direct standard upgrade with no COP files
- D. Export the database directly into Unity Connection

Architect's selection: A

Design rationale

For the documented 11.5-to-15 path, the guide identifies PCD 15 Migration Task and Fresh Install with Data Import rather than a direct standard or direct refresh upgrade. The selected path must also meet readiness, FIPS, platform, and COP requirements.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 8-18

DESIGN DECISION 48 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

NGM will move its cluster to new hardware, change the hypervisor and virtual-machine configuration, and assign new node hostnames and addresses as part of the Release 15 project.

Which overall method fits these combined changes?

- A. Direct migration
- B. Direct standard upgrade only
- C. Switch version without migration
- D. Install a locale COP only

Architect's selection: A

Design rationale

Direct migration is used for site moves, hypervisor or infrastructure changes, VM configuration changes, hostname/address changes, missing direct-upgrade paths, and V2V scenarios where migration reduces complexity. A standard upgrade is intended primarily for application-version change without a required repave.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 4-7

DESIGN DECISION 49 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

The project manager asks when the cluster upgrade can be declared complete. The inactive versions are installed, but some nodes have not switched and database replication has not converged.

What is the correct status?

- A. The upgrade is not complete
- B. The upgrade is complete when the publisher inactive partition is installed
- C. The upgrade is complete before any node reboots
- D. The upgrade is complete when RTMT is downloaded

Architect's selection: A

Design rationale

The guide defines completion as all cluster nodes completing the inactive-version upgrade, all nodes completing switch-version and reboot, and database replication completing across all nodes. Installing software only on inactive partitions does not complete the cluster upgrade.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 3-4

DESIGN DECISION 50 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

NGM uses Unified CM with IM and Presence. The change plan switches IM and Presence nodes before the Unified CM nodes.

Which sequence should replace the proposed plan?

- A. Unified CM publisher, Unified CM subscribers, IM and Presence database publisher, IM and Presence subscribers
- B. IM and Presence subscribers, IM and Presence publisher, Unified CM subscribers, Unified CM publisher
- C. All nodes simultaneously with no ordering
- D. TFTP nodes only, followed by endpoints

Architect's selection: A

Design rationale

The documented sequence switches Unified CM first, beginning with the publisher and then subscribers, followed by the IM and Presence database publisher and subscribers. The plan must also respect clusterwide sequencing and allow replication to complete.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 14-18 and 73-76

DESIGN DECISION 51 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

Before approving the maintenance window, the architect wants a supported automated assessment of versions, disk layout, platform conditions, and other issues that could block the Release 15 upgrade.

Which tool should be run?

- A. Pre-upgrade Upgrade Readiness COP file
- B. A CMS Space report
- C. A Unity Connection call-handler export
- D. An Expressway search rule

Architect's selection: A

Design rationale

The Upgrade Readiness COP file records versioning and runs checks for issues that can interfere with the upgrade. Cisco strongly recommends running it before the upgrade, and the workflow also uses a post-upgrade readiness report to verify stability and differences.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 7-8, 46, and 85-87

DESIGN DECISION 52 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

NGM operates in FIPS mode and has an IPsec policy that uses 3DES. The team plans to retain the policy unchanged during migration to Release 15.

What must be done before the project proceeds?

- A. Delete and recreate the IPsec policy on both peers with supported encryption and ESP algorithms
- B. Keep 3DES because Release 15 requires it
- C. Disable FIPS permanently and ignore the policy
- D. Convert the IPsec policy to an unencrypted HTTP connection

Architect's selection: A

Design rationale

Release 15 does not support 3DES for IPsec communication in FIPS mode. The policy must be deleted and recreated with supported algorithms on both nodes that form the tunnel; migration planning must also follow the guide's IPsec disable/re-enable requirements.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 31-32

DESIGN DECISION 53 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

NGM uses certificate-based IPsec authentication between Unified CM nodes, but the policy references self-signed certificates.

What change is required before upgrading?

- A. Reconfigure IPsec to use a CA-signed certificate
- B. Leave the self-signed certificate because the upgrade ignores IPsec
- C. Replace IPsec with TFTP
- D. Use a phone MIC as the server certificate

Architect's selection: A

Design rationale

The upgrade fails when certificate-based IPsec uses self-signed certificates. The guide requires a CA-signed certificate for this authentication model and directs administrators to disable IPsec policies on cluster nodes before migration, then reconfigure as required.

Source basis: Unified CM 15 Upgrade and Migration Guide, p. 32

DESIGN DECISION 54 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

Unified CM uses DNS, but the paired IM and Presence cluster is configured without DNS and uses different name-resolution behavior.

How should the architect correct the design before upgrade?

- A. Use a consistent DNS model for both products and the same DNS server when DNS is enabled
- B. Keep mixed-mode DNS because it is recommended
- C. Remove all hostnames only from Unified CM
- D. Use Expressway-E as the sole DNS replacement

Architect's selection: A

Design rationale

Mixed-mode DNS deployments are not supported. Unified CM and IM and Presence must both use DNS or both not use it; when DNS is used, they should use the same DNS server so name resolution is consistent.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 24-25

DESIGN DECISION 55 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

A firewall between Unified CM nodes throttles repeated SSH connections and aggressively closes sessions. Similar behavior caused a subscriber installation to fail in testing.

Which network change should be included in the upgrade plan?

- A. Keep TCP port 22 open and unthrottled and adjust or disable interfering firewall behavior during installation
- B. Block TCP 22 on every node
- C. Permit only UDP 5060
- D. Route upgrade traffic through CMS

Architect's selection: A

Design rationale

The guide requires port 22 connections to remain open and unthrottled because subscriber installations create multiple rapid connections to the publisher. Firewalls in the path may need to be disabled or have timeouts increased during installation; a broad permit rule alone may not prevent session interference.

Source basis: Unified CM 15 Upgrade and Migration Guide, p. 25

DESIGN DECISION 56 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

The proposed Release 15 cluster contains one publisher, five active call-processing subscribers, five standby subscribers, two TFTP servers, and media nodes.

Which design limit is violated?

- A. The cluster exceeds the maximum of four subscriber nodes plus four standby nodes
- B. A Unified CM cluster may contain only one subscriber total
- C. TFTP nodes are never permitted
- D. The publisher cannot coexist with media nodes

Architect's selection: A

Design rationale

The guide limits a Unified CM cluster to four subscriber nodes and four standby nodes, for eight subscribers total. It also limits the total number of servers in the cluster, including publisher, TFTP, and media servers, to 21. The proposed active/standby subscriber count violates the first limit.

Source basis: Unified CM 15 Upgrade and Migration Guide, p. 26

DESIGN DECISION 57 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

After the upgrade, the team confirms that the web interface loads and proposes closing the change. The architect wants objective evidence that endpoint and resource registration survived.

Which validation should be added?

- A. Compare RTMT Device Summary counts with the recorded pre-upgrade counts
- B. Verify only that the publisher responds to ping
- C. Check only the CSSM login page
- D. Review only one phone wallpaper

Architect's selection: A

Design rationale

The guide directs the team to use RTMT Voice/Video Device Summary to compare registered phones, gateways, media resources, and other station devices against the values recorded before the upgrade. This identifies missing registrations that a simple GUI or ping test cannot detect.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 97 and 119

DESIGN DECISION 58 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

All nodes are on Release 15 and device counts match. NGM still needs a service-level acceptance test before returning the system to normal operations.

Which test plan is most complete?

- A. Run the post-upgrade COP and test voicemail, internal/PSTN/shared-line calls, transfer, conference, presence, CTI, BLF, and IM and Presence functions
- B. Place one internal call only
- C. Verify only that the publisher has the new version
- D. Test only the administrator login

Architect's selection: A

Design rationale

The post-upgrade workflow calls for the post-upgrade COP plus functional testing across call types, shared lines, conferencing, transfer, barge/privacy/DND, presence, CTI, BLF, and IM and Presence functions. This validates user-facing behavior, not merely software version or node reachability.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 109-120

DESIGN DECISION 59 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

NGM uploaded custom ringtones and phone backgrounds to one TFTP node before the upgrade. The cluster has two TFTP servers, and users registered through the second node do not receive the custom files.

What should the engineer have designed into the migration procedure?

- A. Back up and restore custom TFTP content and upload it to both TFTP servers
- B. Expect Unified CM to copy every custom file automatically to all TFTP nodes
- C. Store the files only on Expressway-E
- D. Replace the files with LDAP attributes

Architect's selection: A

Design rationale

Custom TFTP files are not automatically distributed to every node. The upgrade guide includes backing up custom ringtones/backgrounds and states that file-management operations must be performed on both TFTP servers when two are deployed, followed by a TFTP service restart.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 94-95 and 121

DESIGN DECISION 60 | RELEASE 15 UPGRADE AND MIGRATION ARCHITECTURE**Architect scenario**

A failed change requires NGM to return a direct-upgrade cluster to the previous software version. After switching nodes back, database state is not converging.

Which recovery activity belongs in the rollback plan?

- A. Switch the cluster or affected nodes to the previous version and reset database replication as documented
- B. Delete the publisher and rebuild every phone manually
- C. Convert the cluster to CMS
- D. Disable all subscriber services permanently

Architect's selection: A

Design rationale

The upgrade guide provides procedures to switch the cluster or individual nodes to the previous version and includes resetting database replication. A credible rollback design must account for both software-version reversal and restoration of consistent cluster replication.

Source basis: Unified CM 15 Upgrade and Migration Guide, pp. 62-63

Compact instructor answer key

Full scenarios and rationales appear with each question.

Enterprise Architecture and Endpoint Strategy

1-A | 2-B | 3-A

Unified CM Clustering, Dial Plan, and Multi-Cluster Design

4-A | 5-A | 6-A | 7-A | 8-A | 9-A | 10-A | 11-A | 12-A | 13-A | 14-A | 15-A | 16-A | 17-A | 18-A

Conferencing Architecture

19-A | 20-A | 21-A | 22-A | 23-A

Collaboration Edge, Remote Access, and PSTN

24-A | 25-A | 26-A | 27-A | 28-A | 29-A

Voice Messaging, Operations, and Licensing

30-A | 31-A | 32-A | 33-A | 34-A | 35-A

Security and Bandwidth Management

36-A | 37-A | 38-A | 39-A | 40-A | 41-A | 42-A | 43-A | 44-A

Release 15 Upgrade and Migration Architecture

45-A | 46-A | 47-A | 48-A | 49-A | 50-A | 51-A | 52-A | 53-A | 54-A | 55-A | 56-A | 57-A | 58-A | 59-A | 60-A

Source documents

- Preferred Architecture for Cisco Collaboration Release 15 On-Premises Deployments, Design Overview, November 2024.
- Upgrade and Migration Guide for Cisco Unified Communications Manager and the IM and Presence Service, Release 15 and SUs, supplied edition updated through February 2026.