SYMBEEO

PUBLIC

DESIGN STUDY

Stadium Wi-Fi 7 and 5G neutral host for 60,000 seats

Complete design on current platforms

CAPABILITY	INDUSTRY	SETTING
Networking	Sports & Entertainment	Stadium operator
DOCUMENT	**VERSION**	**DATE**
NET-006	1.3	Oct 10, 2026

WRITTEN BY

Mark Winston, Principal Network Architect

© 2026 Symbeeo. All rights reserved.

Document control

Document	NET-006	Version	1.3
Issued	Oct 10, 2026	Status	Issued by Symbeeo
Classification	Public	Supersedes	1.2, Sep 27, 2026
Capability	Networking	Industry	Sports & Entertainment
Author	Mark Winston	Role	Principal Network Architect
Credentials	CCIE, CISSP, CCSP, CCISO, CISM, Adopting Zero Trust (Forrester)		
Approval	Approved by Edwin Ozer, Founder, Oct 10, 2026. Issued by Symbeeo, Oct 10, 2026. Design study: every figure is vendor-published, a design target or a marked assumption.		
Sign-off	"An engagement under this design is signed by the practice lead before any build proceeds."		

Contents

1 · Scope 3
1c · Public implementations this design follows 4
1d · End-of-sale check, read Sep 25, 2026 5
2 · Requirements register 5
3 · Architecture overview 6
4 · Design by subsystem 7
5 · Failure behavior 8
6 · Limits 9
7 · Lessons learned 9
8 · The author 9

© 2026 Symbeeo. All rights reserved. · Public

CONVENTIONS

Source tags. [S] figure read from the vendor's own current page on Sep 18, 2026; controller figures and end-of-sale status read Sep 25, 2026 (§1d) · [S*] figure from the vendor's page summary where the page itself could not be opened · [A] design assumption, to be confirmed by the signing engineer · [T] design target: the record's outcome figure and anything derived from it. No figure comes from any engagement, file or asset. A row with more than one tag is counted once: as a published figure if any tag is [S] or [S*], otherwise as an assumption if any tag is [A], otherwise as a design target.

Table 1. Revision history

Date	Version	Change
Sep 18, 2026	1.0	First issue.
Sep 20, 2026	1.1	Public implementations added; figures reconciled with published sources.
Sep 27, 2026	1.2	Figures and platform details rechecked against published sources.
Oct 10, 2026	1.3	Approval line now reads: approved by the Founder, issued by Symbeeo. Mark Winston remains the author.

1 · Scope

Who it is for. The technology director of a venue operator with a 60,000-seat stadium and a separate arena, whose bowl Wi-Fi was designed for one device per three seats, and who has three mobile carriers each asking for their own in-building system.

Typical buyer [A]. A stadium operator with a 60,000-seat venue and an arena of 15,000 seats on the same site. Two controller rooms in the stadium, one in the arena. 30 events a year in the stadium, 120 in the arena. Existing Wi-Fi 5 bowl deployment, existing single-carrier DAS at end of life.

What is in. Bowl and concourse Wi-Fi 7 in the stadium, arena Wi-Fi 7, the access switching that powers both, the controller pairs, roaming design, and the IP backhaul, fiber, power and space for a carrier-provided neutral-host 5G system. **What is out.** The neutral-host radio system itself (carrier-supplied; the design provides what it needs); ticketing and point-of-sale applications; broadcast and production networks.

Assumptions. Cisco carries the stadium bowl and concourse, Aruba carries the arena, so the operator's two existing vendor relationships are kept [A]. Fiber exists from every distribution room to the controller rooms [A]. Three carriers agree on one neutral-host system [A].

Related documents, read Sep 18, 2026.

- Cisco Wireless 9176 Series Access Points data sheet — https://www.cisco.com/c/en/us/products/collateral/wireless/wireless-9176-series-access-points-ds.html
- Cisco Catalyst CW9800H1 and CW9800H2 Wireless Controllers data sheet (updated Aug 10, 2026), read Sep 25, 2026 — https://www.cisco.com/c/en/us/products/collateral/networking/wireless/wireless-lan-controllers/cat-cw9800h1-cw9800h2-wireless-controllers-ds.html
- Cisco Catalyst C9800-40/-80 end-of-sale and end-of-life notice, read Sep 25, 2026 — https://www.cisco.com/c/en/us/products/collateral/wireless/catalyst-9800-series-wireless-controllers/catalyst-c9800-wireless-lan-controller-eol.html
- Cisco Catalyst 9300 Series Switches data sheet — https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-9300-series-switches/nb-06-cat9300-ser-data-sheet-cte-en.html

© 2026 Symbeeo. All rights reserved. · Public

- HPE Aruba Networking 750 Series Campus Access Points QuickSpecs — https://www.hpe.com/us/en/collaterals/collateral.a50009211enw.html
- Cisco Private 5G product page — https://www.cisco.com/site/us/en/products/networking/wireless/private-5g/index.html
- Cisco Design Guide CX, Wireless for Large Public Networks (doc 222000), read Sep 20, 2026 — https://www.cisco.com/c/en/us/support/docs/wireless/catalyst-9800-series-wireless-controllers/222000-design-guide-cx-wireless-for-large-pub.html
- Cisco Catalyst 9800 Series Configuration Best Practices, read Sep 20, 2026 — https://www.cisco.com/c/en/us/td/docs/wireless/controller/9800/technical-reference/c9800-best-practices.html
- HPE press release, college stadium Wi-Fi 6E for 101,915 seats (May 7, 2024), read Sep 20, 2026 — https://www.hpe.com/us/en/newsroom/press-release/2024/05/university-of-tennessee-boosts-game-day-experiences-for-fans-with-wireless-connectivity-to-all-102000-seats-using-wi-fi-6e-and-ai-powered-infrastructure-from-hpe-aruba-networking.html

1c · Public implementations this design follows

Deployment rows are real public deployments, each dated. Where no public deployment matches, the row is Vendor documentation: the vendor's document that this design, Symbeeo's own, is built on.

Table 2. Public implementations this design follows

Implementation	Who published it · date	What it settles for this design	URL
Vendor documentation. Design Guide CX, Wireless for Large Public Networks, doc 222000	Cisco · updated Mar 3, 2026	For high-density venues: 20 MHz channel width is highly recommended, use every available channel, plan at about 75 clients per radio and well below 50 % of AP capacity, one 9800-80 HA pair handles a large stadium with well over 1,000 APs (the CW9800H1 that replaces it carries the same 6,000 AP / 64,000 client scale [S]), 802.11r FT and OKC on, site tags equal to WNCD count and grouped by RF proximity	https://www.cisco.com/c/en/us/support/docs/wireless/catalyst-9800-series-wireless-controllers/222000-design-guide-cx-wireless-for-large-pub.html
Vendor documentation. Catalyst 9800 Series Configuration Best Practices	Cisco · updated Sep 4, 2026	Load a controller to about 80 % of its AP and client scale — about 4,800 APs and about 50,000 clients on a 9800-80, CW9800H1 or CW9800H2 (read Sep 25, 2026)	https://www.cisco.com/c/en/us/td/docs/wireless/controller/9800/technical-reference/c9800-best-practices.html
Deployment. A 101,915-seat college stadium, Wi-Fi 6E with HPE Aruba Networking	HPE · May 7, 2024	An Aruba bowl at 1.7× this design's stadium, 31 Gbps recorded at one event, managed by Central on Premises — the Aruba side of §4.3 proven at stadium scale	https://www.hpe.com/us/en/newsroom/press-release/2024/05/university-of-tennessee-boosts-game-day-experiences-for-fans-with-wireless-connectivity-to-all-102000-seats-using-wi-fi-6e-and-ai-powered-infrastructure-from-hpe-aruba-networking.html

Applied in this design: R11 and §4.1 channel width in the bowl is 20 MHz on 5 and 6 GHz [S]; R9, §3, §4.5 and §6 size the controllers as two pairs, each under Cisco's 80 % ceiling, since one pair would carry 94 % of client scale [S]. The 9800-80 is past end of sale; the CW9800H1 carries the same scale [S] (§1d).

© 2026 Symbeeo. All rights reserved. · Public

1d · End-of-sale check, read Sep 25, 2026

Table 3. End-of-sale check, read Sep 25, 2026

Item	Status read Sep 25, 2026	Action	Source
Catalyst 9800-80 (C9800-80-K9)	announced Jan 9, 2025; end of sale Dec 31, 2025; last date of support Dec 31, 2030; migration CW9800H1 or CW9800H2	**replaced by CW9800H1**	[S] https://www.cisco.com/c/en/us/products/collateral/wireless/catalyst-9800-series-wireless-controllers/catalyst-c9800-wireless-lan-controller-eol.html
CW9800H1 / CW9800H2	6,000 APs, 64,000 clients, up to 100 Gbps, 1 RU, SSO 1:1, IOS XE 17.14.1 minimum (data sheet updated Aug 10, 2026); not on the 9800 end-of-sale listing. The 17.14.x train itself is end-of-sale-announced, so the build runs a current recommended release chosen at staging [A]	added	[S] https://www.cisco.com/c/en/us/products/collateral/networking/wireless/wireless-lan-controllers/cat-cw9800h1-cw9800h2-wireless-controllers-ds.html · https://www.cisco.com/c/en/us/products/wireless/catalyst-9800-series-wireless-controllers/eos-eol-notice-listing.html
CW9176D1 / CW9176I	series orderable, released Nov 11, 2024; no end-of-life notice	kept	[S] https://www.cisco.com/c/en/us/support/wireless/wireless-9176-series-access-points/series.html
C9300X-48HX, C9300X-NM-2C	no C9300X model on the 9300 end-of-sale listing	kept	[S] https://www.cisco.com/c/en/us/products/switches/catalyst-9300-series-switches/eos-eol-notice-listing.html
Catalyst 9500X family (site core)	no C9500X model on the 9500 end-of-sale listing	kept	[S] https://www.cisco.com/c/en/us/products/switches/catalyst-9500-series-switches/eos-eol-notice-listing.html
HPE Aruba Networking AP-755	HPE does not pre-announce end of sale; neither the QuickSpecs page nor the HPE Store could be opened	kept; end-of-sale status **not verified**	—
Aruba arena gateway/controller	named by family only, so no part number to check	not checked [A]	—
Cisco Private 5G page	live; no end-of-sale statement	kept as cited	[S] https://www.cisco.com/site/us/en/products/networking/wireless/private-5g/index.html
Design guide 222000 · 9800 best practices	updated Mar 3, 2026 · Sep 4, 2026; best practices names the 9800-80 and CW9800H1/H2 together at about 4,800 APs and 50,000 clients	kept	[S] https://www.cisco.com/c/en/us/td/docs/wireless/controller/9800/technical-reference/c9800-best-practices.html

2 · Requirements register

Table 4. Requirements register

#	Requirement	Value	Source
R1	Seats	60,000 stadium · 15,000 arena	[A]

© 2026 Symbeeo. All rights reserved. · Public

#	Requirement	Value	Source
R2	Devices	1 per seat = 60,000 in the bowl	[T]
R3	Bowl AP density	1 AP per 60 seats = 1,000 bowl APs	[A]
R4	Bowl AP	Wi-Fi 7, tri-radio 4x4, directional 70×70 beam on 5 and 6 GHz	[S] CW9176D1: 8 dBi, 70×70 on 5 and 6 GHz
R5	Concourse AP	Wi-Fi 7, tri-radio 4x4, omnidirectional	[S] CW9176I
R6	Bowl and concourse AP uplink and power	1 × 10G mGig, 39 W at 802.3bt	[S] CW9176 series
R7	Arena AP	Wi-Fi 7, three concurrent 4x4 radios, 18.7 Gbps aggregate, 2 × 10GBASE-T, 51 W class 6	[S] Aruba AP-755
R8	Access port	10G mGig, 90 W UPOE+	[S] C9300X-48HX
R9	Stadium controller	CW9800H1 HA pairs loaded to no more than 80 % of scale: about 4,800 APs and about 50,000 clients per pair; two pairs for the bowl	[S] CW9800H1 6,000 APs / 64,000 clients / 100 Gbps, data sheet https://www.cisco.com/c/en/us/products/collateral/networking/wireless/wireless-lan-controllers/cat-cw9800h1-cw9800h2-wireless-controllers-ds.html; [S] 80 % ceiling, Cisco 9800 best practices https://www.cisco.com/c/en/us/td/docs/wireless/controller/9800/technical-reference/c9800-best-practices.html
R10	Bowl roaming	< 50 ms bowl-wide	[T]
R11	Channel plan, bowl	320 MHz channels available on 6 GHz; 20 MHz used on 5 and 6 GHz for reuse	[S] CW9176 6 GHz; [S] 20 MHz for high density, Cisco design guide 222000 https://www.cisco.com/c/en/us/support/docs/wireless/catalyst-9800-series-wireless-controllers/222000-design-guide-cx-wireless-for-large-pub.html
R12	Neutral-host 5G	one system shared by 3 carriers; design supplies fiber, power, space, IP backhaul	[T]; [A] carrier-supplied
R13	Neutral-host backhaul	2 × 100G from head-end to the site core	[A]
R14	Per-device throughput at full bowl	≥ 5 Mbps down, at an assumed 50 % of bowl devices active at once	[A]

Fourteen rows; seven carry a vendor figure, five are design assumptions, two are design targets.

3 · Architecture overview

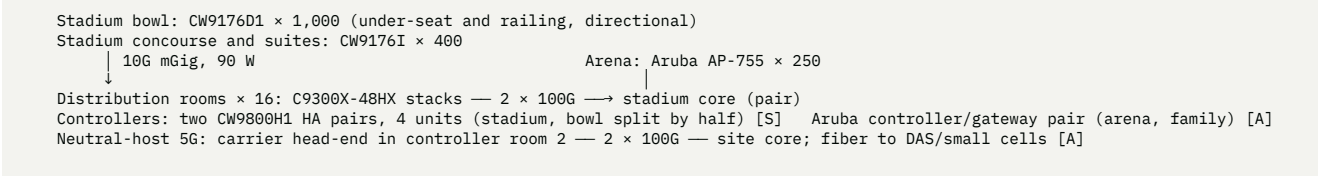


Figure 1. Stadium and arena wireless

One directional AP model in the bowl, one omnidirectional model in the concourses, one switch model in every

© 2026 Symbeeo. All rights reserved. · Public

distribution room, two stadium controller pairs. The arena is its own Aruba island with its own controller pair and a shared site core. The neutral host gets what any tenant needs: fiber, power, rack space and an IP path.

Table 5. Architecture overview

Role	Product (exact model)	Qty	Capacity used	Why this unit
Bowl AP	Cisco CW9176D1	1,000	60 seats per AP [A]	70×70 directional beam, 8 dBi on 5/6 GHz [S]
Concourse and suite AP	Cisco CW9176I	400	1 per 80–100 m² [A]	omnidirectional, same family [S]
Arena AP	HPE Aruba Networking AP-755	250	60 seats per AP [A]	18.7 Gbps aggregate, 3 × 320 MHz on 6 GHz [S]
Access switch	Cisco C9300X-48HX	40 (16 rooms, stacks of 2–3) [A]	48 × 10G mGig, 90 W UPOE+ [S]	10G and 802.3bt on every port [S]
Arena access switch	Cisco C9300X-48HX	set by the arena survey [A]	250 AP-755 at 51 W [S]	same switch model as the stadium [A]
Uplink module	Cisco C9300X-NM-2C	40	2 × 100G [S]	dual 100G per stack
Stadium controller	Cisco Catalyst CW9800H1 (2 HA pairs)	4	per pair 700 of about 4,800 APs (15 %); 30,000 of about 50,000 clients (60 %) at Cisco's 80 % ceiling [S][T]	Cisco's named migration product for the end-of-sale 9800-80, largest client scale in the CW9800 family, 1 RU [S]; 60,000 clients exceeds one pair's 80 % load [S]
Arena controller	Aruba gateway/controller (family; model not verified)	2	250 APs [A]	[A]
Neutral-host 5G	carrier-supplied system (not a vendor-list product)	1	3 carriers [T]	[A]

4 · Design by subsystem

4.1 Bowl Wi-Fi.

CW9176D1: three Wi-Fi 7 radios, 4x4 MU-MIMO, 7 dBi on 2.4 GHz with 80×80 beam, 8 dBi on 5 and 6 GHz with 70×70 beam, aggregate 18–23 Gbps by configuration, one 10G mGig port, 39 W at 802.3bt [S]. Under-seat and handrail mounting at one AP per 60 seats [A], 1,000 APs (R3). Flexible Radio Assignment sets the bowl to 5/5/6 GHz where 2.4 GHz adds nothing but noise [S] mode; [A] choice. Channel plan: 20 MHz on 5 and 6 GHz, all available channels, minimum transmit power [S] Cisco design guide 222000 (R11). Rejected: omnidirectional APs in the bowl — no beam control across 60,000 co-channel devices (R4).

4.2 Concourse, suites, back of house.

CW9176I, omnidirectional 5/5/6 dBi [S], 400 units at one per 80–100 m² and one per two suites [A]. 2.4 GHz kept on for point-of-sale and legacy devices [A].

© 2026 Symbeeo. All rights reserved. · Public

4.3 Arena Wi-Fi.

Aruba AP-755: three concurrent 4x4 radios, 1.4 Gbps on 2.4 GHz, 5.8 Gbps on 5 GHz, 11.5 Gbps on 6 GHz, 18.7 Gbps aggregate, optional dual-6 GHz mode at 28.8 Gbps, two 10GBASE-T ports with link aggregation or failover, 802.3bt class 6 at 51 W [S]. 250 units at one per 60 seats [A]. Arena controller pair is Aruba by family; the model is not verified on the vendor page [A]. Rejected: extending the Cisco controller to the arena — the operator's arena team runs Aruba and keeps its tooling [A].

4.4 Access switching and power.

C9300X-48HX: 48 × 10G mGig, 90 W UPOE+ per port, up to 3,290 W per switch with dual 1,900 W supplies, StackWise-1T [S]. 1,400 stadium APs at 39 W [S] = 54.6 kW total; 40 switches × 3,290 W = 131 kW available, 42 % used. Arena APs at 51 W [S] on the same switch model; the arena switch count is set by the arena survey and is not in these figures [A]. Uplinks C9300X-NM-2C, 2 × 100G per stack to the site core [S]. Rejected: 802.3at PoE+ switches — the AP-755's class 6 draw exceeds PoE+ (R7).

4.5 Controllers and roaming.

CW9800H1: 6,000 APs, 64,000 clients, up to 100 Gbps, SSO 1:1 active standby, 4 × 25G and 8 × 1/10G uplinks, 1 RU, IOS XE 17.14.1 minimum [S], read Sep 25, 2026. The H1 is taken over the H2 (2 × 40G) because its four 25G ports carry the full 100 Gbps [A]. Cisco's best practice loads a controller to about 80 % of scale, about 50,000 clients [S], so 60,000 bowl devices need two HA pairs, each carrying half the bowl at 60 % of that ceiling **[S][T]**. Roaming: one SSID, one client VLAN pool per controller, 802.11r fast transition and 802.11k enabled, site tags per WNCD grouped by RF proximity [S]; the bowl halves are split so a seat-to-seat roam stays within one controller pair, and inter-controller mobility covers the crossing [A] (R10). Rejected: CW9800M — 32,000 clients [S], about 25,600 at the 80 % ceiling, below the 30,000 each pair carries. Rejected: Catalyst 9800-80 — end of sale Dec 31, 2025, migration CW9800H1 or CW9800H2 [S] (§1d).

4.6 Neutral-host 5G.

The system is carrier-supplied and shared by three carriers (R12); Cisco's Private 5G page lists venues as a use case but does not describe a neutral-host or multi-operator product [S], so no vendor-list product is named for the radio system. The design provides: two racks and 20 kW in controller room 2, single-mode fiber to 48 remote-unit locations, 2 × 100G from the head-end to the site core, and a separate VRF per carrier [A] (R13). Rejected: three separate carrier DAS systems — three times the fiber, power and space.

4.7 Site core and backhaul.

Site core pair (Catalyst 9500X family, model to be confirmed, [A]) with 2 × 100G from each distribution room and 2 × 100G to the neutral-host head-end. Internet: 2 × 100 Gbps from two providers [A]; 60,000 devices × 50 % active × 5 Mbps (R14) = 150 Gbps, inside 200 Gbps; one provider lost leaves 100 Gbps, about 3.3 Mbps per active device [A]. Peak demand is bounded by the internet links, not the Wi-Fi.

5 · Failure behavior

Table 6. Failure behavior

Failure	Behavior	Source
One bowl AP down	neighbors at 60-seat spacing absorb the section at reduced rate	[A]
One stack member down	APs on that member dark; each AP is single-homed (one 10G port) so its section loses coverage until swap	[S] CW9176 single port; [A]

© 2026 Symbeeo. All rights reserved. · Public

Failure	Behavior	Source
Active stadium controller down	standby of that pair takes over statefully; its 30,000 clients keep sessions	[S] SSO 1:1
Arena AP loses one uplink	second 10GBASE-T port carries link and power	[S] AP-755 redundant failover
One 100G uplink from a room down	second 100G carries; room at half backhaul	[A]
Neutral-host head-end power lost	all three carriers' in-venue 5G off until power returns; Wi-Fi unaffected	[A]

6 · Limits

- Client load is 60 % of Cisco's 80 % ceiling per controller pair; one device per seat is a target. A measured 1.3 per seat (78,000) puts each pair at 39,000, 78 % of the ceiling; above about 1.7 per seat (100,000 devices) a third pair is needed.
- The CW9176 series has one Ethernet port, so bowl APs are single-homed; redundancy is by neighbor coverage, not by link.
- The neutral-host 5G radio system is not a vendor-list product and is designed here only as a tenant.
- The arena controller and the site core are named by family only.
- Sub-50 ms roaming is a design target measured at first build; it depends on client behavior as much as on the network.

7 · Lessons learned

None yet — this is a design study; populated after the first build against it.

8 · The author

WRITTEN BY

Mark Winston

Principal Network Architect

CCIE, CISSP, CCSP, CCISO, CISM, Adopting Zero Trust (Forrester)

Signed off by Edwin Ozer, Founder.

© 2026 Symbeeo. All rights reserved. · Public

SYMBEEO

Each vendor's tool shows you their option. We show you all of them against one requirement.

Compared. Then Delivered.

hello@symbeeo.com · symbeeo.com

© 2026 Symbeeo. All rights reserved.

Product and company names and logos are their owners' trademarks, shown only to identify the lines Symbeeo sources. Naming a vendor or showing its logo does not mean the vendor sponsors or approves Symbeeo's comparisons or any recommendation Symbeeo makes.

Figures are as published by their sources on the dates given in this document; figures marked [A] are assumptions.

NET-006 · Version 1.3 · Oct 10, 2026