WHITE PAPER

Private 5G for Oil & Gas and Petrochemical Operations

The transport layer for everything the hardwired control system cannot reach: the field technician, the remote asset, the marine berth, and the safety system watching the worker.

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Contents

PART 01

The Case for Private 5G in Oil & Gas

Why connectivity is the constraint — and how private 5G resolves it.

Industrial connectivity has been wired by necessity

Industrial connectivity has always been wired by necessity, not engineering preference. The wired DCS and SIS are not going away and should not. But the work that happens between those fixed nodes, at the field device, the rotating asset, the remote tank farm, the marine berth, has a connectivity requirement the wired plant cannot satisfy. Private 5G is the transport layer that fills that gap: deterministic, segmented, and fully under the operator's control.

The architecture is not a replacement. It is additive infrastructure that extends what the hardwired layer structurally cannot reach, enforces a clean boundary between IT and OT traffic, and delivers the latency and reliability that real-time industrial applications require.

Overview: The case for private 5G in oil and gas

Downtime, infrastructure cost, and safety risk converge at the same source: the limits of legacy connectivity. This overview page explains how private 5G addresses each, and why the ROI case in oil and gas is structurally different from other verticals.

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> **Oil & Gas / Petrochemicals overview on celona.io**
> https://www.celona.io/unmatched-private-wireless-for-oil-gas-refineries-and-petrochemicals-plant

Making 5G effective for both OT and IT systems

Celona CTO Mehmet Yavuz on what it takes to run a single private 5G network that serves operational technology and IT side by side: traffic prioritization, end-to-end segmentation, and industrial-grade reliability. Published on Automation.com, the publishing arm of the ISA.

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> **Read the article on Automation.com**
> https://www.automation.com/article/making-5g-effective-both-ot-it-systems

Financial returns: where private 5G earns its ROI

Reduced infrastructure and maintenance costs, lower unplanned downtime, workforce productivity gains, and process automation combine into a measurable financial case. This page covers each driver and links to supporting case material.

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> **Financial returns blog on celona.io**
> https://www.celona.io/5g-lan/how-private-5g-is-delivering-the-biggest-financial-returns-in-oil-and-gas

Seven critical considerations for private 5G deployment

Spectrum licensing, hazardous-area certification, OT protocol integration, latency requirements, device ecosystem, brownfield overlay constraints, and operations model. A practitioner's checklist for evaluating a deployment.

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> **Seven considerations blog on celona.io**
> https://www.celona.io/5g-lan/the-seven-critical-considerations-for-private-5g-in-oil-and-gas

Insider's guide: operational efficiency and digital transformation

Geoffrey Cann's analysis of how private wireless fits into the broader O&G digital transformation picture, with a practitioner's view on operational efficiency gains and the decision framework for deployment.

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> **Insider's guide on celona.io**
> https://www.celona.io/private-5g-in-oil-and-gas-an-insiders-guide-to-operational-efficiency-and-digital-transformation

The role of private 5G in shaping the future of oil and gas

From IoT sensor networks to autonomous operations and augmented-reality maintenance, this page maps the connectivity requirements that define the next operating model for refineries and petrochemical sites.

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> **Future of O&G blog on celona.io**
> https://www.celona.io/5g-lan/the-role-of-private-5g-in-shaping-future-of-oil-and-gas-industry

LNG terminal connectivity: berth, tank farm, and safety

LNG terminals have distinct connectivity requirements at the marine berth, the cryogenic tank farm, and across the hazardous-area footprint. Custody transfer telemetry, gas detection, worker location, and SCADA extension each carry specific latency, reliability, and segmentation demands that the hardwired DCS and SIS cannot satisfy alone. The spoke page covers the architecture and deployment model in full.

> IN THIS PAPER
> **LNG terminal spoke page → →**

Start with the problem, not the technology.

Bring your highest-value use case. A working session maps it to a solution architecture: the connectivity, the devices, and the integration with your existing control and safety systems.

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PART 02

LNG Terminals

Berth, cryogenic tank farm, and the hazardous-area safety footprint.

Private 5G for LNG Terminals

The transport layer for everything the hardwired DCS and SIS cannot reach: the marine berth, the cryogenic tank farm, the roving technician, and the safety system watching the worker.

The process is well understood. The connectivity gaps inside it are not.

An LNG terminal's control system is hardwired and stays that way. What private 5G adds is the transport layer for everything the wired system structurally cannot reach: the field technician, the marine berth sensor, the remote tank farm monitor, the safety system watching the worker. Each one matters. Some of them are a direct revenue and commercial-dispute matter, not an IT concern.

Gas arrives at the terminal, goes through treatment to remove impurities, enters liquefaction where it is cooled to minus 260 degrees Fahrenheit, moves into cryogenic storage tanks, and then loads to tanker at the marine berth. Every stage of that sequence has a data requirement. Most of those requirements are served by the hardwired DCS and SIS. The gaps are in the places those systems structurally cannot reach.

- Inlet / Treatment Metering, H_2S and CO_2 removal. Hardwired instrumentation covers the process. Mobile technician access to records and permits is not covered.
- Liquefaction Cryogenic cooling. Fixed sensors on the process. Rotating equipment health monitoring and inspection workflow are not.
- Cryogenic Storage Tank-level, pressure, temperature — the core alarms are hardwired. Remote boil-off monitoring, predictive maintenance data, and tank-roof camera feeds are not.
- Marine Berth Loading arm telemetry, custody transfer metering, ship–shore safety links. Revenue and commercial dispute exposure at every loading event.

Four structural connectivity challenges across the terminal footprint

Marine berth — revenue exposure

Custody transfer telemetry, loading arm positioning, and ship–shore communications at the berth directly affect cargo invoicing and dispute resolution. A data gap is a commercial event.

Cryogenic tank farm — remote monitoring

Boil-off gas monitoring, remote tank-level telemetry, and inspection workflows at cryogenic tanks require connectivity that cable runs across a large facility footprint cannot economically provide.

Classified zones — conduit economics

Adding cable infrastructure in hazardous-area classified zones requires hot-work permits, conduit runs, and site shutdowns. The cost and schedule are disproportionate to most data requirements.

Connected worker — mobile coverage gap

Field technicians, inspection crews, and marine berth operators work across large footprints. Permit-to-work systems, maintenance records, and safety monitoring require continuous connectivity that point-to-point radio cannot provide.

At the marine berth, the network is not IT infrastructure. It is commercial infrastructure.

Ownership of LNG changes hands at the berth. The measurement of what was loaded, when it was loaded, and at what composition, is the basis for the invoice, the cargo documentation, and any subsequent dispute resolution.

A delay in data from a remote metering station, a measurement gap during a critical loading window, or a communications failure between the ship and the terminal safety system is not an operational inconvenience. It is a commercial event with a dollar figure attached to every minute of ambiguity.

Determinism, low latency, and guaranteed data delivery at the berth are contract requirements. The network that carries custody transfer telemetry must meet the same bar as the instrumentation it serves: no data loss, no polling gaps, no contention with other traffic that could delay a measurement during a loading event.

Private 5G with MicroSlicing enforces a dedicated bandwidth allocation for custody transfer telemetry. That slice is not shared. No other application — video feeds, software updates, voice — can preempt it.

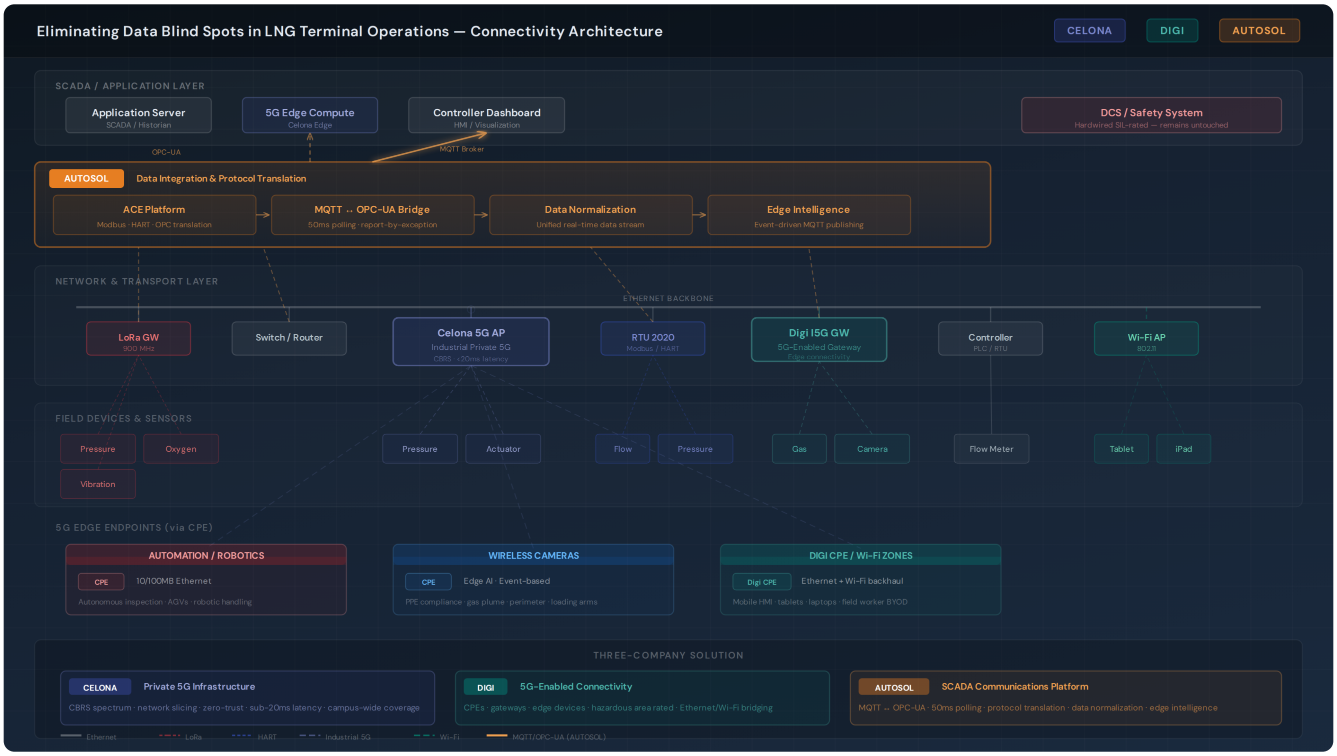
What the network must deliver at the berth and tank farm

The requirements are not marketing claims. They follow from the application.

Minimum network specification for LNG terminal OT applications

Latency	Below 20 milliseconds for OT application traffic. Measured, not modeled. Enforced per application via MicroSlicing.
Traffic isolation	IT and OT traffic segmented at the Celona Edge via VLAN assignment and dedicated ports. No OT traffic on the IT path.
Device identity	AerLoc SIM-based authentication. No device associates without a provisioned SIM credential. No password-based or open association.
Spectrum	CBRS Band 48 (US) or n77/n78 mid-band internationally. Licensed per site. Managed via Celona Orchestrator SAS integration.
MQTT / protocol	MQTT Broker at the edge gateway structures and timestamps field telemetry before transmission. AUTOSOL and OPC integration bring events into existing historian and DCS without changes to receiving infrastructure.
Legacy SCADA	Digi edge gateways aggregate Modbus RTU and non-5G sensors, providing local processing and protocol translation for existing instrumentation without requiring 5G native radio capability at the device.

The DCS and SIS stay hardwired. Private 5G is the transport layer above them.



LNG terminal reference architecture: the hardwired DCS/SIS layer as the foundation, with the private 5G transport layer above it.

Safety on an LNG terminal is proactive and continuous, not reactive and point-in-time.

The DCS and SIS handle process safety. Private 5G handles the worker safety layer that the hardwired system structurally cannot reach: continuous gas detection, real-time location, camera-as-sensor, and physiological monitoring at the equipment.

The DCS and SIS stay hardwired and remain untouched. Private 5G does not touch this layer, does not replace it, and does not interface to it directly at the safety layer. That boundary is explicit and non-negotiable.

Connected gas detection and predictive safety models

Portable gas detectors connected to the private 5G network stream readings continuously to an edge system, rather than triggering only at alarm thresholds. A continuous stream of below-alarm readings from multiple worker-carried detectors across a zone is more information than a single point-source alarm. MicroSlicing guarantees the bandwidth slice for safety sensor traffic regardless of what else is on the radio.

Real-time worker location and mustering

Knowing where everyone is on a terminal covering hundreds of acres, in a declared emergency, with people converging from classified zones and marine berths, is a mustering problem that paper headcounts and voice radio cannot solve at the required speed. Real-time location on the private 5G network, with worker-carried devices, delivers accurate headcounts and zone-specific location without the latency of manual roll-call.

Camera-as-sensor: transmit insight, not footage

Cameras on the private 5G network process locally and transmit structured event data — anomaly detected, zone breached, activity change — rather than raw video streams. This reduces the bandwidth required for visual safety coverage and keeps the radio available for high-priority OT and safety telemetry.

Man-down and physiological monitoring

Worker-carried devices detect fall events, motionlessness, and in advanced configurations, physiological indicators. Alerts route immediately to safety control rooms over the dedicated safety traffic slice. Response time is defined by the alert, not by the patrol schedule.

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Brownfield overlay. Greenfield specification. The same architecture, different entry points.

Private 5G is additive in both contexts. It does not require displacing the existing control infrastructure. It extends what that infrastructure cannot reach.

Brownfield: overlay without disruption

In an operating terminal, trenching through an active classified zone for new fiber cable requires shutdowns, hot-work permits, and durations that are disproportionate to the data value being chased. Private 5G access points mount on existing structural steel without new conduit runs. Coverage provisions in hours from Celona Orchestrator. Digi edge gateways bring existing Modbus RTU and non-5G sensors onto the private 5G network without requiring rip-and-replace of instrumentation.

Greenfield: FEED specification alongside the DCS and SIS

In a new terminal, private 5G is specified in the front-end engineering design alongside the DCS and SIS. It is additive infrastructure that reduces what has to be built in conduit and cable, not a retrofit. Either way, the DCS and SIS stay hardwired and remain untouched.

The latency figure is measured, not modeled.

As process decisions migrate to the point where the work happens, the latency requirement is defined by what the decision needs. The sub-20ms figure meets the real-time reasoning requirement for custody transfer telemetry, safety event response, and connected-worker decision support at the equipment.

MicroSlicing ensures that latency guarantee is enforced per application: custody transfer telemetry and safety sensor traffic are not subject to contention from video feeds or software updates sharing the same radio.

OT application latency	<20 ms measured
Traffic enforcement	MicroSlicing per-app
Spectrum (US)	CBRS Band 48
Device identity	AerLoc SIM-based
IT/OT segmentation	Celona Edge VLAN + port

181-acre industrial deployment, full-buffer load

The architecture described on this page is not theoretical. A 181-acre heavy industrial site running full-buffer network load provided the measurement environment for the sub-20ms latency figure. The deployment covers the complete terminal footprint model: distributed access points, IT/OT segmentation at the Celona Edge, SIM-based device identity, and MicroSlicing-enforced application priority.

Celona Orchestrator provisions coverage, manages spectrum via SAS integration, and provides the operational visibility layer for the network administrator without requiring RF expertise on-site.

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Talk to an LNG specialist.

RF planning workshop with site-specific coverage model, hardware recommendation, and deployment path. Or start with a proof of concept.

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Proof of Concept

https://www.celona.io/5g-lan-poc

PART 03

A Refinery at Scale

Ten access points, a 0.55-square-mile footprint — every figure measured.

What a private 5G refinery deployment looks like at scale

Not a comparison against a network nobody runs. A description of what was actually built across a working refinery, and what was measured walking it.

Ten access points cover a full refinery. No trenching.

A 0.55 square mile refinery, roughly 13 million square feet of process units, tanks, and pipe racks, was covered end to end with ten private 5G access points. The access points mount on the structure that is already there: pipe rack gantries, process units, rooftops, and poles where power and backhaul already exist. There is no trenching, no new conduit, and no cabling run across the live plant to extend coverage.

- Footprint0.55 square miles, approximately 13 million square feet of refinery process area.
- Access pointsTen, covering the full site. Mounted on existing pipe racks, process units, rooftops, and poles.
- Civil worksNone required for coverage. No trenching, no new conduit, no cable runs across the plant.
- Outdoor ratingIP66 outdoor access points. C1D2-certified units available for hazardous-area placement.
- AntennasDirectional or omni, tuned to put coverage where the work happens.

This is the point that matters to an operator evaluating a deployment: the cost and schedule of extending coverage are not dominated by civil works, because the access points use the structure and power that are already in place.

Every figure here is measured, not modeled.

The deployment was validated with a site walkback: a device carried through the refinery while coverage, signal strength, and handover were recorded. The walkback showed coverage better than minus 110 dBm RSRP across the full footprint, including deep inside the metal pipe surroundings where wireless signals are hardest to deliver. Handover between the ten access points was seamless, observable in the PCI transitions as the device moved through the plant.

Coverage (RSRP)	Better than -110 dBm site-wide
Access points	10, full-site coverage
Handover	Seamless, infrastructure-controlled
Connections observed	50 to 60 per hour, sustained
Attach success	100% over a week

Over a week of operation, the network sustained 50 to 60 connections per hour with a 100% device attach success rate. Beyond these headline figures, the running network exposes the full set of RF engineering metrics an integrator works from: SINR distribution, modulation and coding selection, resource block utilization, and per-device throughput and latency, all visible and tracked through the Celona Orchestrator.

Measured RSRP coverage across the refinery footprint. Coverage holds better than minus 110 dBm throughout, including inside dense metal pipe surroundings, with the ten access point locations and handover regions shown.

One network, the work the wired plant cannot reach.

The wired control and safety systems stay wired and remain untouched. What this network adds is the transport layer for everything that happens away from the fixed nodes, the work the hardwired plant structurally cannot reach.

The connected technician

Inspection and maintenance crews capture images and readings in the field, sync to central systems in real time, and pull up a supervisor or remote expert on live video to resolve an issue without leaving the unit.

IoT sensors and digital twin

Sensors that were uneconomic to hard-wire feed condition and process data back to the historian and digital twin models for monitoring and predictive maintenance.

Worker safety

Connected gas detection, real-time worker location, and man-down alerting on worker-carried devices, the safety layer that watches the worker, not just the process.

Cameras and autonomous systems

Wireless cameras for surveillance and safety, and connectivity for robotics and autonomous inspection in areas that are hazardous or impractical to staff continuously.

The differentiator is the architecture, not the radio.

The refinery is one of the hardest radio environments there is: dense metal, tall structures, electrical noise, and a footprint measured in square miles. Coverage holds because the network controls the things that matter in that environment, spectrum access, device identity, traffic prioritization, and infrastructure-controlled mobility. Dedicated spectrum keeps the network clear of the contention and interference that degrade unlicensed alternatives. Per-device, per-application priority through MicroSlicing keeps critical traffic deterministic under load. SIM and eSIM identity means no device is on the network without a provisioned credential.

This is the same architecture that segments IT and OT traffic at the Celona Edge, integrates with existing AAA, NAC, and firewall policy, and is managed through a single Orchestrator console without requiring RF expertise on-site. It is additive infrastructure: it extends the plant, it does not replace the control system that runs it.

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PART 04

The Resonance Device Program

The industrial devices proven on Celona — and how they earned it.

The industrial devices proven on Celona, and how they earned it

Not a compatibility list of every phone that connects. A curated set of industrial-grade devices and platforms validated for reliable operation in a plant, with the tier and status shown honestly.

A consumer phone connecting to 5G tells you nothing about whether a network runs your plant.

Plenty of devices connect to a private 5G network. That is not the question an operator is asking. The question is which devices are built for a hazardous, metal-heavy, around-the-clock plant environment, and which have been proven to work there on Celona infrastructure. The Frequency Resonance Program answers that, and only that.

Resonance is a quality gate, not a marketing badge. Every entry is industrial-grade and purpose-built for plant environments. A wide range of other devices is supported on Celona infrastructure, but may not align to the use case envisioned with the Resonance Program; those remain in Celona's general device compatibility list. Every certification has been through thorough testing, validation, and in the higher tiers, proven deployments.

Four things stand behind every entry.

Tested on Celona

Each device is validated in the Celona lab for signal acquisition, handover, throughput under load, and latency on the private 5G network.

Architecture integration

The device or platform leverages Celona capabilities: SIM-based zero-trust identity, MicroSlicing QoS, IT/OT segmentation, or Layer 2 industrial protocol support.

Independently reviewed

Certified solutions are reviewed by a qualified technical architect who understands plant environments. Not a rubber stamp.

Proven in production

The Certified tier requires live deployment on a customer network under production conditions, with documented reliability metrics.

Infrastructure, then data, then intelligence. In that order.

The tiers follow the real sequence of industrial transformation. Applications cannot run without reliable connectivity, and edge AI cannot be deployed without proven applications generating the data that feeds it.

A device and the application running on it are certified separately. The Durabook U11 tablet is certified at the Infra tier for device connectivity. Rockwell ThinManager running on that tablet is a Data-tier application certification. Each layer of the stack is validated and traceable on its own, so an operator knows both the device and the software have been proven, not assumed.

Devices and platforms by tier and status.

Sort by any column. Filter by tier. Status is shown as it actually stands: Ready means lab-validated and proven capable; Certified means deployment-proven in production; Candidate and In development mean the integration is underway and not yet certified. Nothing here is overstated.

Device / Platform	Type	Tier	Status
Smart-Ex 02 Pepperl+Fuchs	Intrinsically safe 5G handheld (C1D1)	Infra	Ready, inaugural certification
Smart-Ex 203 Pepperl+Fuchs	Intrinsically safe 5G handheld (C1D1)	Infra	Ready, inaugural certification
Tab-Ex 04 Pepperl+Fuchs	Intrinsically safe 5G tablet (C1D1)	Infra	Ready, inaugural certification
RSM-Ex 01 Pepperl+Fuchs	Worker-comms accessory (Bluetooth speaker-mic, pairs with certified handsets)	Infra	Ready, worker-comms accessory
Durabook U11 Durabook	Rugged Windows 5G tablet	Infra	Ready
FortiGate Rugged 70G Fortinet	Rugged firewall / SD-WAN appliance	Infra	Ready. Data-tier integration to follow
ICS-i331 Lanner Electronics	Industrial edge compute appliance	Infra	Ready
IX40 Digi International	Industrial 5G cellular gateway	Infra	Ready
Anybus Wireless Bolt 5G HMS Networks	Industrial wireless connectivity bridge	Infra	In validation
FortiGate 70G, SD-WAN integration Fortinet	IT/OT boundary enforcement, SD-WAN dual-channel	Data	Candidate, reference architecture in development
Experion Field PKS Honeywell	DCS console extension to field devices	Data	Reference case, integration in development
ThinManager Rockwell Automation	Thin-client platform for industrial HMI	Data	Candidate, in development

Device / Platform	Type	Tier	Status
SCADA / MQTT **Autosol with Digi**	SCADA communications and data orchestration	Data	Candidate, reference architecture documented
AI 100 Ultra **Qualcomm**	Edge AI inference accelerator	Intelligence	Vision. Demonstrated at Frequency 2026, no certification at launch

This set is curated and grows by validation, not by submission. A device earns a place by proving itself on Celona infrastructure, not by being added to a catalog. Partners interested in certification engage Celona engineering for lab validation.

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Start with the problem, not the technology.

ABOUT CELONA

Based in Silicon Valley, Celona is a pioneer and leading innovator of enterprise private wireless solutions. The company is credited with developing the industry's first 5G LAN system, a turnkey 4G/5G system that enables enterprises and mobile network operators to address the growing demands for more deterministic wireless connectivity for critical business applications and vital use cases not met by conventional wireless alternatives.

Celona's products and technology have been selected and deployed by a wide range of customers including Verizon, NTT, SBA Communications, Standard Steel, and Haslam Sports Group. To date, the company has raised $135 million in venture funding from Lightspeed Venture Partners, Norwest Venture Partners, NTT Ventures, Cervin Ventures, DigitalBridge and Qualcomm Ventures.

For more information, please visit celona.io and follow Celona on LinkedIn @ linkedin.com/company/celonaio

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