Universidad Autónoma de TAMAULIPAS

Unidad Académica Multidisciplinaria Reynosa-AZTLÁN

XR-UAT

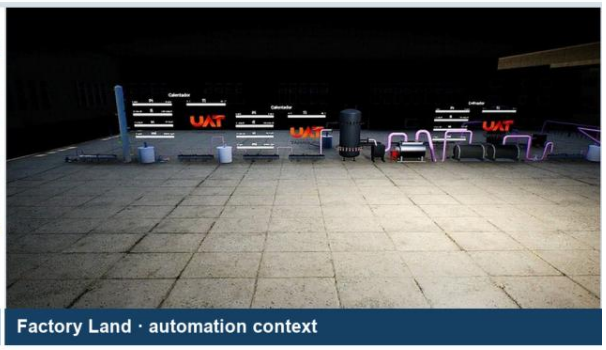
SCALABILITY · FINAL JUDGE SUBMISSION

A governed replication model for lab practices, machines, modalities, instructors and evidence

Petro Land · well operations

Petro Land · refinery operations

Chemical Land · fractional distillation



Factory Land · automation context

Current XR-UAT evidence from the Unreal Engine ecosystem. Figures are labelled as native captures, documentary records or explanatory diagrams.

QS Reimagine Education Awards 2026

Immersive Experiential Learning · Academic – Early Stage · Scalability pathway

Universidad Autónoma de Tamaulipas · UAM Reynosa-Aztlán · México

Evidence reviewed through 10 August 2026

1. Direct responses to the QS Scalability questions

XR-UAT is scalable because it feeds from practices validated by professionals, its design allows it to be implemented by different institutions: industries and schools. Its current capacity and future reach are kept distinct by the different packages that will be added to.

Q1. QS criterion response

What aspects of your project make it transferable, adaptable or scalable to new contexts, audiences, or settings?

XR-UAT is transferable: its replication unit is a practice packet rather than a copied 3D scene. Each packet combines a curriculum-aligned decision task, machine or context definition, delivery profile, instructor guide, student evidence, assessment instrument and acceptance checklist. The realms reuse a data-driven machine catalogue, canonical HMI, MQTT state handling and evidence templates while retaining discipline-specific variables and safety limits. A partner can begin with browser/desktop, progress to VR, add onsite MR after passthrough acceptance, and use SARA on compatible Android devices. The remote-MR presentation path is now integrated in Digital Land; live-camera origin, latency, reconnect and physical MQTT actuation remain separate acceptance conditions. Simulation and offline modes remain valid and visibly labelled; they do not fabricate live telemetry. Curriculum, language, network policy, equipment inventory and local safeguarding can be configured, so learning objective and minimum evidence standard remain stable while deployment adapts to each institution.

Length check: within the 150-word limit

Q2. QS criterion response

What are your projected growth or expansion plans over the next 12–24 months and 3–5 years, and what steps will enable this progression?

During the next 12–24 months, XR-UAT will complete the Pozo 08, Petro Land refinery-operations and fractional-distillation evaluations; lock anonymized datasets; document participant flow; and produce accepted through-lens MR and MQTT/device traces. Each practice will receive a versioned owner, curriculum map, safety conditions and technical acceptance record. One or two partners will then be selected through a rubric, a local instructor will be trained, and completion, performance, incidents, support load and implementation fidelity will be compared across sites.

Within three to five years, the objective is a governed network of partner-led practices. The university will steward architecture, content versions, evidence standards and quality assurance, while partners select relevant packets and adapt approved local elements. Expansion will be driven by validated practices and documented implementations—not by counting demonstrations—supported by a controlled content registry, machine catalogue, instructor preparation pathway and minimum evidence dataset.

Length check: within the 150-word limit

1. Direct responses to the QS Scalability questions · continued

Q3. QS criterion response

Describe the resources, funding, or financial model that support scalable growth, including any plans to secure additional support or diversify sustainability mechanisms.

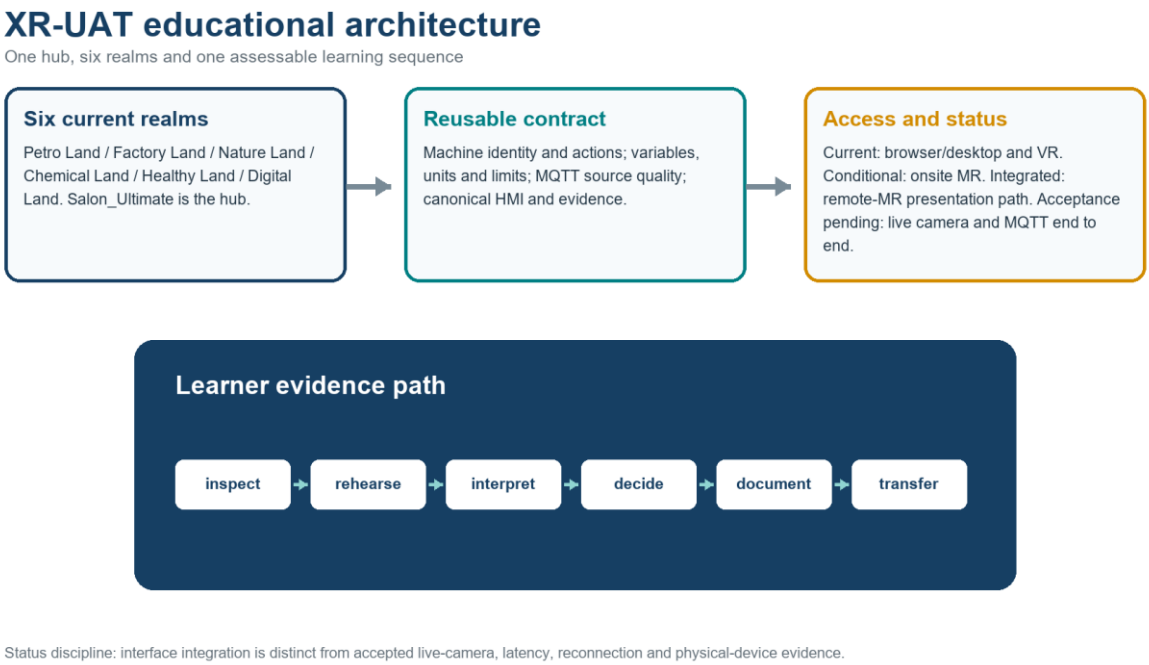
Scalable growth will use a blended institutional model. The *Universidad Autónoma de Tamaulipas* provides the academic home, staff expertise, Unreal base, laboratories and governance for platform stewardship. Competitive grants will support validation, accessibility, modules and equipment integration. Partnerships may fund onboarding, instructor preparation, local adaptation and hardware connectivity, while supervised theses and student projects contribute content under review and version control.

Funding remains relevant because headsets, computing, capture equipment, networks, maintenance and partner support create recurring costs. Growth will not assume every site purchases identical hardware: desktop-first deployment, reusable practice packets and optional MQTT/MR layers reduce the entry threshold. Before expansion, each partner will confirm curriculum fit, safeguarding, technical readiness, data governance and a named local owner. Sustainability will be monitored through cost per accepted practice, instructor support time, reuse rate, incidents, completion and learning evidence rather than revenue.

Length check: within the 150-word limit

Scaling mechanism	What is standardized	What remains local
Practice packet	Task, evidence and acceptance structure	Curriculum mapping and timetable
Machine contract	Identity, state, actions and data quality	Variables, units and safety limits
Delivery profile	Mode and acceptance logic	Hardware, room, network and safeguarding
Partnership	Minimum evidence and quality gates	Named owner, permissions and support model

2. The unit of replication

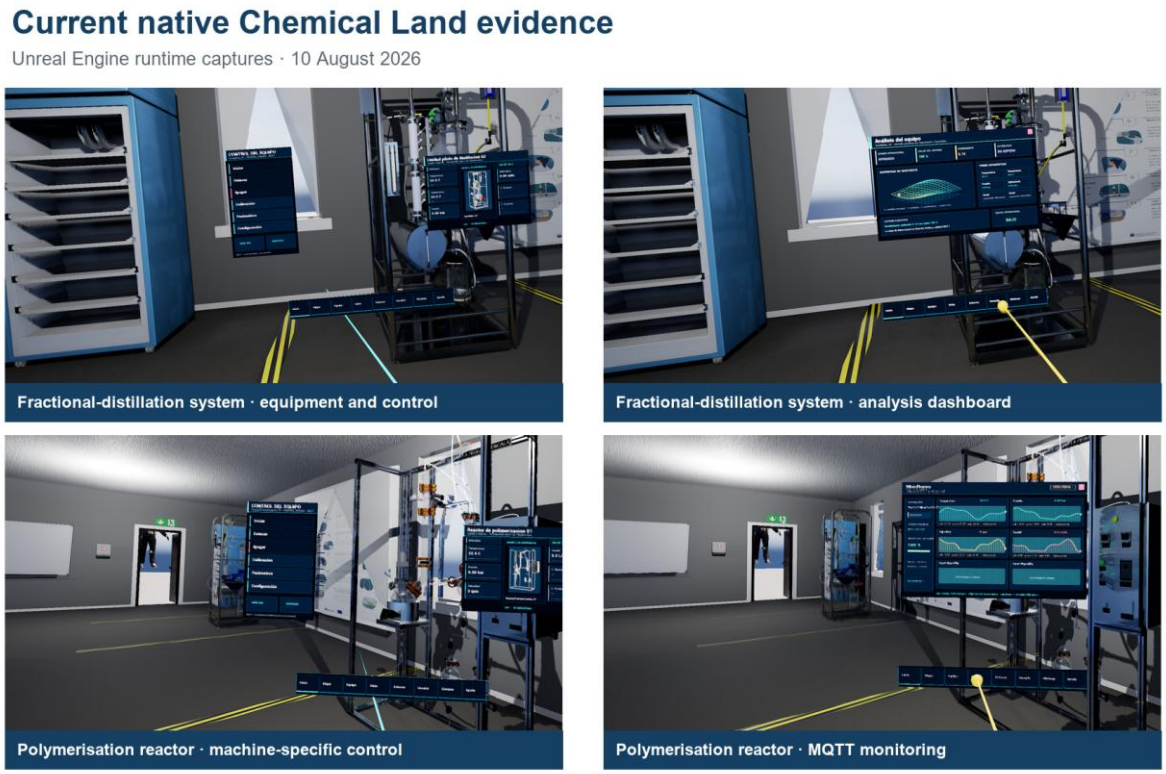


Explanatory diagram of the shared architecture. Transfer occurs through a complete practice packet, not by copying an Unreal map alone.

A minimum viable practice packet contains the learning objective and prerequisites; procedure and decision points; configured machine or context; modality profile; instructor guide; student task; assessment and data instrument; safety conditions; and technical/educational acceptance checklist. Scale is achieved only when a partner can deliver and evaluate that packet responsibly.

Common core	Locally adapted element
Machine identity, state, actions and evidence grammar	Equipment inventory, variables, units and safety limits
Instructor/student packet structure	Curriculum mapping, language and timetable
MQTT topic/payload conventions	Broker security, credentials and network policy
Modality acceptance logic	Hardware, room conditions and safeguarding
Minimum evidence dataset	Institutional consent, retention and assessment policy

3. Reuse across machines and realms

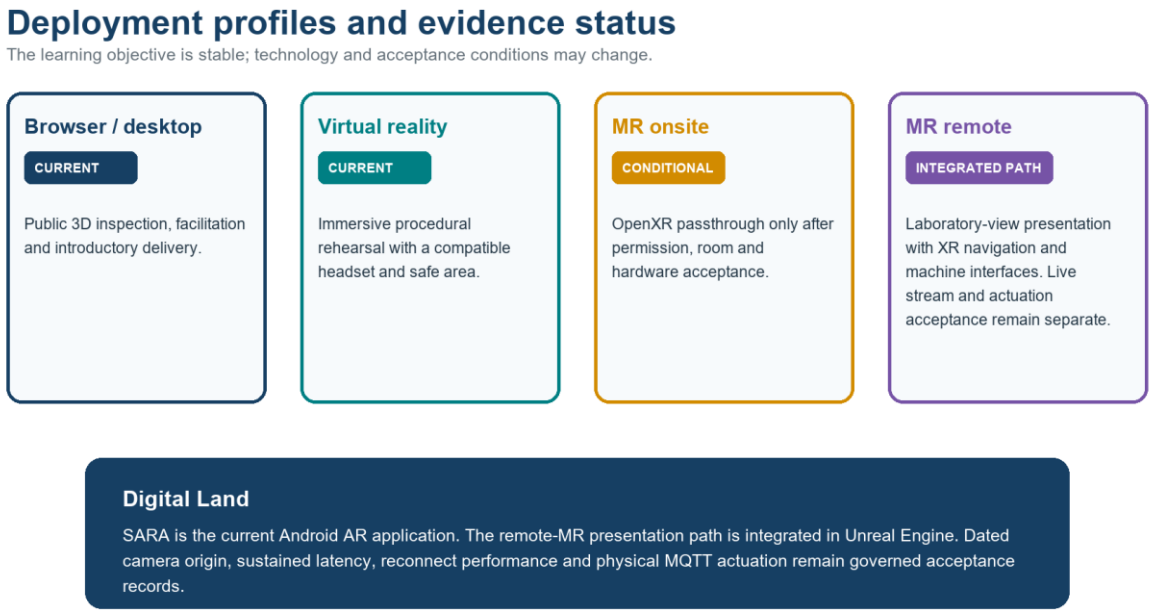


Current native Chemical Land proof. The fractional-distillation system and polymerization reactor retain one interface grammar while displaying machine-specific identity, images, state and MQTT configuration.

Cross-domain reuse rests on the machine contract rather than on former laboratory labels. Petro Land, Factory Land, Nature Land, Chemical Land, Healthy Land and Digital Land are the six current public contexts. Factory Land contains the manufacturing, automation and control context. Instrumented assets can reuse the canonical HMI and state services without forcing every realm to expose the same variables or maturity level.

Machine Id also governs the telemetry and command topic pair, reducing ambiguity between the screen, the data source and the evidence record. New assets can be added through a catalogue/configuration pathway instead of duplicating an entire interface and logic chain.

4. Modality as a deployment choice

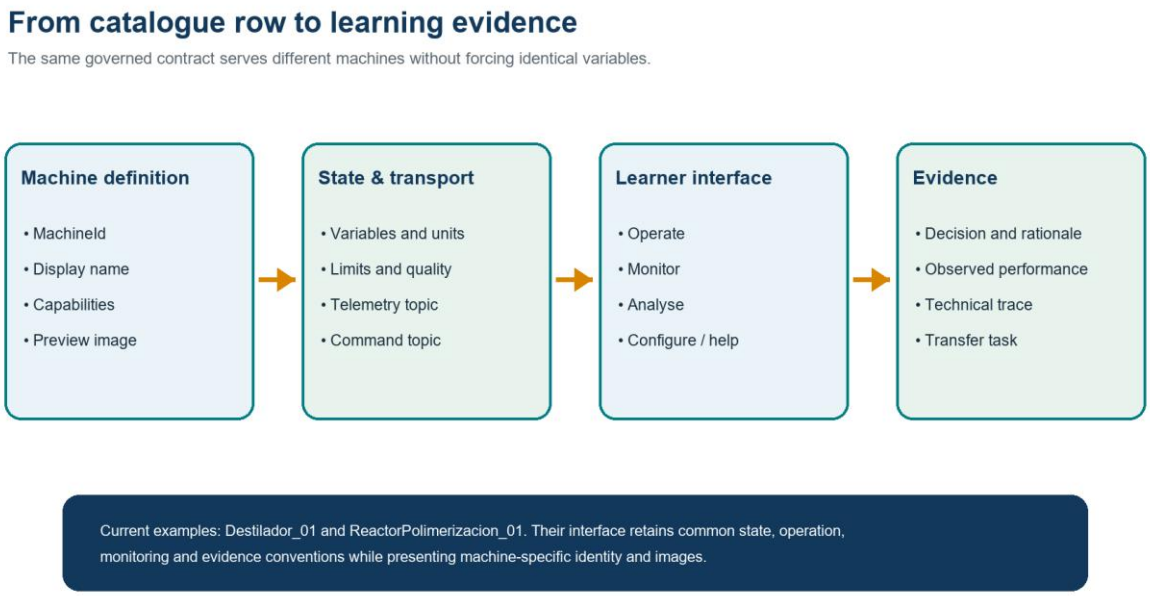


Explanatory profile diagram. Institutions may begin with the least demanding valid profile and advance after readiness checks.

Profile	Use	Minimum local requirement
Browser / desktop	Public 3D inspection, review, facilitation and introductory delivery	Modern browser or compatible computer and validated package
VR	Immersive procedural rehearsal	Headset, safe area and facilitator
MR onsite	Overlay in the physical context	Compatible OpenXR passthrough and explicit permission
MR remote · integrated path	Laboratory-view presentation with XR navigation and equipment interfaces	Camera/stream chain, latency, network acceptance and reconnect test
SARA · Digital Land	Android AR guidance	APK, visual target, compatible device and safeguarding

This ladder lowers entry costs. A partner can inspect the public 3D laboratory and validate pedagogy and facilitation through browser/desktop delivery before adding VR, MR or hardware connectivity. The public site labels demonstration telemetry and authorized MQTT connectivity separately. The learning objective remains stable while the presentation profile changes.

5. Governed MQTT and hardware integration

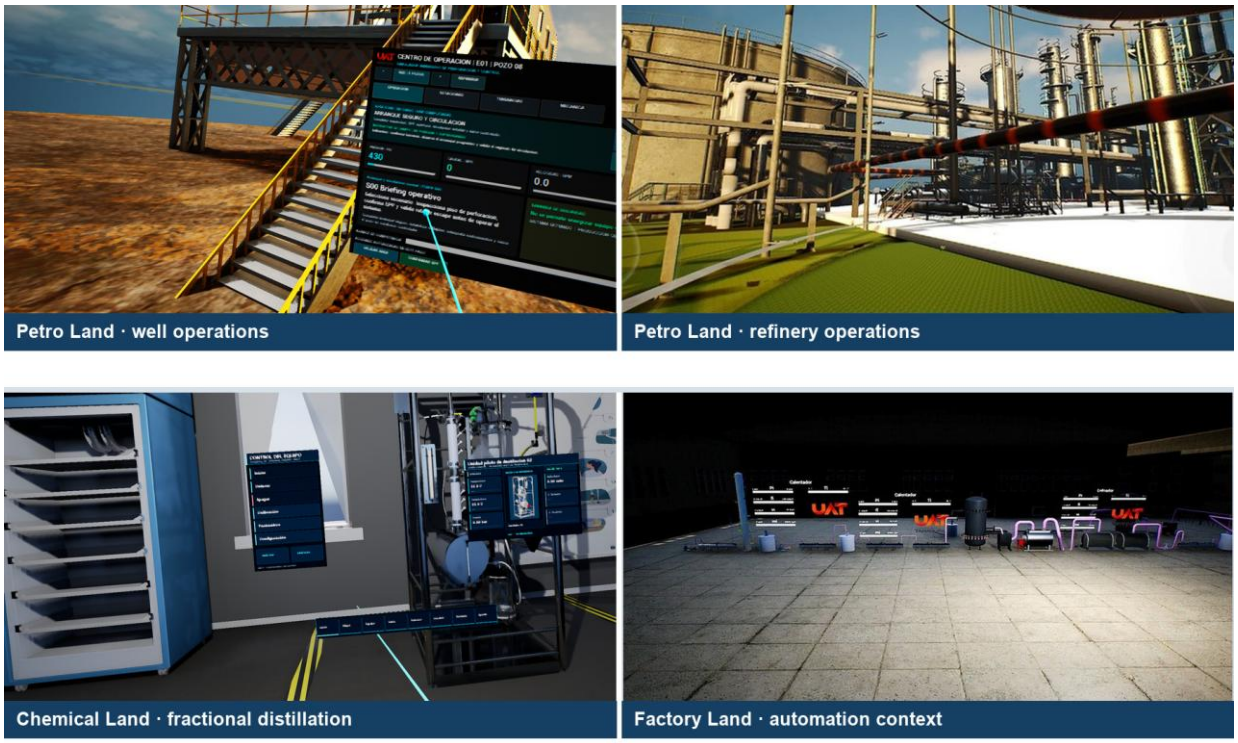


Explanatory contract from machine configuration to evidence.

MQTT enables authorized microcontrollers and laboratory systems to enter the same state model where infrastructure permits. It is optional for replication: a practice may operate in clearly labelled simulation or offline mode without live measurements. When hardware is claimed, acceptance requires a dated device inventory, broker trace, visible HMI state change, command/response evidence and disconnect/reconnect test.

This separation is essential for institutions with different equipment, cyber-security rules and network readiness. XR-UAT standardizes the educational contract while allowing the data source and local safety conditions to remain explicit.

6. Three cross-context replication pilots



The practices shown are “well operations”, “refinery line-up” and “fractional distillation”. Factory Land shows the automation context.

Pozo 08 tests procedural sequence, hazard reasoning and transfer with an anticipated group of approximately 16 learners using Meta Quest 3. Petro Land refinery operations reuse the evidence logic for line-up and safe start-up. Chemical Land fractional distillation adds explicit data-source verification and modality recording. Together they test whether one governed packet can move across contexts without weakening the evidence standard.

7. Growth plan: 12–24 months

0–6 months · Complete the evidence loop

- Complete the three controlled evaluations; freeze versioned, anonymized datasets and report participant flow.
- Produce one accepted through-lens MR record and one end-to-end MQTT/device trace.
- Assign an owner, version, curriculum map, safety conditions and acceptance result to every released practice.
- Reconcile the institutional reach register so that all public figures have a defined denominator.

6–12 months · Become partner-ready

- Select one or two partners through a readiness rubric covering curriculum, instructor, facilities, safeguarding, network and data governance.
- Train a local instructor and record permitted adaptations, support time and implementation fidelity.
- Run a small accepted deployment and compare completion, rubric performance, incidents and technical support load.

12–24 months · Demonstrate auditable replication

- Publish a controlled implementation handbook and minimum evidence dataset.
- Maintain a versioned content registry, machine catalogue and issue/change log.
- Report adoption, reach, learning and implementation quality as separate outcomes.

8. Growth plan: three to five years

The medium-term objective is a governed network of partner-led practices. The university will own architecture stewardship, content/version approval, evidence standards and quality assurance. Partners will select relevant packets, map them to local curricula and have access to approved instructors, hardware and safeguarding conditions.

Institutional role	Responsibility
UAT stewardship	Core platform, academic oversight, version registry, standard evidence and quality assurance
Partner institution	Curriculum mapping, named instructor, facilities, permissions, local data governance and accepted delivery
Research network	Comparative evaluation, accessibility, dissemination and peer-reviewed validation
Student pathway	Supervised projects under review, testing and version control

9. Resources and sustainability

The current institutional base supplies academic leadership, development capability, existing laboratory contexts and the Unreal project. Incremental growth requires founding for cost computing and headset maintenance, capture and 360 equipment, microcontrollers, network services, instructors' preparation, technical support and evidence management.

Mechanism	Purpose	Control
Institutional core support	Platform stewardship, essential infrastructure and academic oversight	Annual owner, maintenance plan and release priorities
Competitive grants	Evaluation, accessibility, research and new modules	Milestones, ethics/data plan and deliverables
Partner implementation support	Onboarding, training, adaptation and hardware integration	Readiness review and costed scope
Projects	Supervised content and research capacity	Academic review, testing and version control

Sustainability will be judged through cost per accepted practice, support hours, reuse rate, technical incidents and learning evidence. Revenue is not required to establish early-stage educational viability, and no unverified revenue figure is claimed.

10. Quality gates and evidence chain

Gate	Minimum acceptance condition	If unmet
Educational	Objective, task and assessment aligned	Revise before delivery
Technical	Package launches; state quality visible; required profile works	Use validated fallback or stop
Infrastructure	Inventory, credentials, broker/stream and room checked	Make no live-device/MR claim
Safety	Instructor, area, stop conditions and supervision confirmed	Do not run the activity
Data	Permission, anonymous IDs, access and retention defined	Collect no scored data
Evidence	Attendance, completion, incidents and outcomes recorded	Implementation remains descriptive

Language and evidentiary convention

Institutional records issued in Spanish remain the originals. English titles, captions and summaries in this submission are faithful reviewer translations. Photographs prove the activities implemented; learning is based from countable records and identified assessment files.

Scalability conclusion

XR-UAT can scale responsibly because it replicates an educational packet supported by reusable machine, HMI, modality and evidence contracts. The architecture lowers the technical threshold while preserving local curriculum, safety and data requirements. The next milestone is: the first fully documented cross-site replication cycle.