The story of Uruguay's self-developed Data telecommunications infrastructure—from the first program-controlled Telex exchange to URUPAC—is one of the most remarkable, against-the-odds triumphs in Latin American technological history. It is a narrative defined by intellectual audacity, national necessity, and an unexpected synergy between visionaries inside a state monopoly and exiled academic talent.

Here is the comprehensive narrative framing the context, the achievement, and its enduring significance.

Sovereign Signals: How Uruguay Built Its Own Digital Backbone

1. The Context: Fragile Links and a Changing Economy

In the early 1970s, Uruguay was undergoing a fundamental economic shift. The country began diversifying beyond its traditional exports of beef and wool, expanding into non-traditional agricultural goods and international services. This expanding trade required fast, reliable international communication.

However, voice telephony in the pre-satellite era was prohibitively expensive, and facsimile (Fax) technology was still in its infancy and unsuited for noisy, high-cost overseas circuits. Automatic Telex was the absolute lifeblood of global commerce: it was text-based, legally binding, independent of time zone differences, and cost-effective.

Yet Uruguay's telecommunications infrastructure was dangerously fractured:

- **A Divided System:** Telex services were split between two separate state authorities. The Telegraph authority (**DGT**) operated an automated 200-number Siemens electro-mechanical Strowger exchange (±60V) linked to Italcable. The electricity and telephony authority (**UTE**) operated a separate 280-number, home-built manual switchboard (0/120V) linked to the American carrier ITT.
- **Neglected Assets:** Equipment sat underutilized or trapped in warehouses. UTE had acquired an automated 80-number SEL switch from Germany, but it remained sealed in its original crates due to jurisdictional litigations over DGT's telegraph monopoly.
- **Geographical Limits:** Modern telecommunications barely existed outside Montevideo.

In 1972, the state moved to consolidate Telex under UTE (and later, in 1974, created **ANTEL** as a dedicated state telecommunications enterprise). To fix the fragmented telex network, UTE assigned the task to a young engineer freshly back from Germany: **Juan Carlos Miguez**.

2. Demystifying the Giants: The Spark of Local Ingenuity

Juan Carlos Miguez brought a critical, rare perspective. Upon graduating in 1969, he had

worked at Siemens in Munich on the hardware development of their fully electronic Telex project (EDS - a failure). Inside the German multinational, going beyond Hardware design and considering the whole system Miguez witnessed a sobering reality: behind the polished glossy sales brochures of European tech giants lay deep engineering struggles, and fragile designs.

When Miguez returned to Uruguay, he knew two things:

1. Foreign technology was neither infallible nor unachievable.
2. Uruguay could not afford to wait -and pay for expensive foreign vendors to solve its problems.

Incremental Upgrades & Building Credibility

Miguez started with pragmatism. He unboxed the forgotten SEL switch, integrated it with the existing network, and opened a direct automatic Telex link to Argentina—instantly easing operator workloads.

He then designed custom transistorized adapter circuits. Manufactured by Uruguay's local industry, and using spare Strowger equipment from Telephony, these circuits allowed incoming automatic traffic through the German switches to automatically dial and route into the 300 manual subscribers, while handling the $60/120 V electrical conversions. This also resulted in less work for the operators and much better service.

He pushed coverage into the interior of the country by deploying small, locally built manual consoles in **Punta del Este** and **Paysandú**. When the network's Germanium-based TOR (Teleprinting Over Radio) units drifted in the heat and failed, Miguez used thermocouples to identify the hottest nodes and replaced vulnerable Germanium transistors with heat-tolerant Silicon components.

These and other low-cost, high-impact interventions delivered double-digit growth in Telex traffic and earned Miguez the deep trust of his superiors.

In 1975, within the framework of a short ITU Fellowship, JC Miguez visited Siemens in Munich and Frederick,Maryland. where the well-reputed Eltex switches were produced. None of them showed any piece of equipment.

3. The Bold Gamble: Commissioning the Local Consortium

By 1976, demand was exploding. ANTEL's conservative Planning Division attempted to do what state utilities always did: hire consultants and draft an international tender to purchase a massive, 3,000-line Telex exchange from global conglomerates like Siemens, ITT, NEC. or Eltex

Miguez proposed an audacious alternative: **Instead of importing an expensive turn-key system, ANTEL should fund the design and construction of an electronic, program-controlled Telex switch manufactured entirely in Uruguay.** A viable project was conceived and specified.

When the military regime purged the public university (UDELAR), a generation of brilliant scientific minds—mentored by late **Professor Ricardo Pérez Iribarren**—was forced out of

academic research and into private enterprise. Engineers like **Juan Grompone**, **Néstor Macé**, **Jaime Jerusalmi**, and **Enrique Salles** channeled their talents into domestic technology firms.

Two of these firms joined forces to create a specialized consortium:

- **CONTROLES** (formerly GMS): Specialized in hardware architecture and industrial electronics.
- **INTERFASE:** Specialized in real-time software engineering and system architecture.

In 1977, ANTEL took a leap into the unknown. It signed a contract granting the consortium an advance payment to fund a two-phase project:

1. **Phase 1:** Build and test a 128-line prototype with technical support from ANTEL.
2. **Phase 2:** If successful, commission up to 8 production switches to scale nationally.

Though Miguez had to leave ANTEL next year for personal reasons, his young assistant, **Eng. Rodolfo Fariello**, stepped up to lead the technical liaison, safeguarding the vision.

4. Defeating the Multinationals: From Telex to URUPAC

While the local engineers worked on the prototype, ANTEL's Planning Division pushed ahead with an international tender for a foreign system, with the help of international consultants. The tender ended in a total fiasco—the specifications were inadequate, and every foreign proposal had to be rejected. A second international tender yielded the same result.

Meanwhile, the local consortium delivered a miracle.

The 128-Line Triumph (1980)

In 1980, CONTROLES and INTERFASE deployed their 128-line electronic prototype. Built around **Triple-Modular Redundancy (TMR)** using three Intel Single Board Computers voting in real-time, the switch offered unprecedented quality and reliability. After months of debugging and rigorous stress-testing, it was placed online to serve Uruguay's 100 highest-volume commercial subscribers. It performed flawlessly.

With international bids stalled, and seeing that local prices were competitive, ANTEL expanded the architecture. The consortium upgraded the system modules to 256 and eventually 512 lines. The legacy manual and mechanical gear was decommissioned, and **100% of Uruguay's national and international Telex traffic began flowing through locally designed and manufactured switches.**

EVOLUTION OF URUGUAYAN DATA NETWORK

1980: 128-Line Telex Prototype ——▶ 1983: Scaled National Telex Network

1995: 0900 Dial-up Internet ◄—— 1988: URUPAC X.25 Packet Network

(SLIP/IP over URUPAC) (32-line X.25 node)

The Birth of URUPAC and Early Internet Access

By the late 1980s, demand shifted toward high-speed data transmission. ANTEL's Planification and International consultants recommended a hyper-complex, dual-circuit/ packet-switching exchange that proved unworkable to the budget constrained Utility.

ANTEL pivoted back to its proven local partners. Negotiating a change in pending Telex deliveries, ANTEL commissioned the consortium to build a 32-line **X.25 packet-switching node**.

Against the predictions of foreign experts, the consortium successfully built the **URUPAC** node, quickly expanded after testing

- By **1988–1990**, Uruguayan academics and professionals were dialing 0800 access numbers to connect their microcomputers to global X-25 networks like Compmail used by IEEE volunteers
- By **1995/1996**, TCP/IP protocols were layered directly onto URUPAC. By dialing 0900 1234, any citizen in Uruguay with a PC and a modem could instantly establish a SLIP connection to the Internet and receive an email address.

URUPAC served as the bedrock of Uruguay's digital transition until the late 1990s, when commodity mass-produced routers took over. The system remained operational in legacy roles until its final, honorable decommissioning in **2012**.

5. Significance & Legacy

The achievement of Miguez, Fariello, Grompone in INTERFASE, Salles and Mace in CONTROLES, extends far beyond a technical milestone. Its legacy can be measured across four dimensions:

- ### 1. Technological Sovereignty

In an era when developing nations were treated merely as passive consumers of expensive First-World technology, Uruguay built, operated, and maintained its own core digital communications infrastructure. The local switches matched or outperformed international alternatives in price, speed of deployment, and support.

- ### 2. Birth of Uruguay's Software & Tech Export Industry

The capital, confidence, and real-world experience generated by the Telex and URUPAC projects laid the ground code for Uruguay's modern technology ecosystem. The engineers trained during this period went on to establish companies that made Uruguay the leading

software exporter per capita in Latin America.

- ### 3. Proof of Development through SOUND Engineering Principles

The project proved that small teams with good formation, using fundamental engineering principles—such as fault-tolerant triple-modular redundancy and modular hardware design—could outperform massive global monopolies plagued by bloated sales promises.

- ### 4. Democratization of Early Access

Because the domestic system was affordable and tailor-built for the country's scale, Uruguay achieved near-universal digital connectivity far earlier than many of its regional neighbors, paving the way for future feats like digitalization of Telephony and the pioneer *Plan Ceibal*.