

# ISDN

[Go to BRI](#) (Basic Rate Interface 2 channel Microlink) for Residential and PRI (Primary Rate Interface 30 channel Macrolink) for Business

ISDN ITU Geneva Integrated Services Delivery Network UK 1986, Canberra 1989, phone fax data (X.25) at 64 Kbps per channel. Closed 2022

The user is providing historical facts about **ISDN (Integrated Services Digital Network)**, noting its ITU Geneva standards roots, rollouts in the UK (1986) and Canberra, Australia (1989), its 64 Kbps per channel data/voice/fax capabilities (utilizing protocols like X.25 for signalling/packet data), and its eventual closure around 2022.

This is a fact-seeking/lookup query where the user has laid out the core parameters. I should provide a direct, concise confirmation and a structured summary of ISDN's legacy, milestones, and its phase-out.

Let's load the relevant skill just in case (none specifically fit perfectly, maybe standard lookup). No special skill is mandatory here. Let's do a quick search to ensure accurate validation of the timeline (UK 1986, Canberra 1989, shutdown 2022).

**ISDN (Integrated Services Digital Network)** stands as a monumental stepping stone in telecommunications history, marking the first time data, voice, and fax were systematically integrated over standard copper lines using end-to-end digital signals.

## ITU Standards & The Core Technology

- **The ITU Framework:** Formally developed under the International Telecommunication Union (ITU-T/CCITT) "I-series" recommendations, the architecture standardized the simultaneous transmission of multiple network services.
- **The 64 Kbps B-Channel:** The foundation of ISDN was built on the **64 Kbps Bearer (B) channel**, which carried the actual voice or user data.
- **Signalling and Packet Handling:** A separate **Delta (D) channel** (typically operating at 16 Kbps or 64 Kbps) handled control signalling. In its early configurations, it leveraged **X.25 packet-switching protocols** to manage data packet delivery, user signalling, and link verification over the network.

## Regional Rollouts & Milestones

- **United Kingdom (1986):** British Telecom (BT) began early digital trials in the mid-1980s, eventually establishing commercial offerings around 1986 to address corporate requirements for high-speed file transfers and early desktop videoconferencing.
- **Australia / Canberra (1989):** Telecom Australia (now Telstra) pioneered a unique proprietary version of ISDN locally before aligning with European standards (ETSI). In July 1989, it launched **Macrolink**, the country's first national commercial ISDN service, aimed primarily at business PABX systems and banking data infrastructure.

## The Final Phase-Out (2022 and Beyond)

As modern broadband technologies like DSL, cable, and eventually pure fibre-to-the-premises (FTTP) proliferated, ISDN transitioned from a high-end luxury to legacy infrastructure.

- **Australia:** Telstra systematically stopped taking new orders for ISDN services in 2019, culminating in the **final decommissioning of the remaining active ISDN lines in 2022** as users were successfully migrated onto the National Broadband Network (NBN).
- **Global Deadlines:** While Australia completely severed its ties with the old network in 2022, other major telecom providers worldwide followed a tight sunset schedule, with Openreach in the UK transitioning all legacy PSTN and ISDN services to full Voice over IP (VoIP) systems.

Would you like to explore **how the 64 Kbps standard was chosen** based on pulse-code modulation (PCM) limits, or see a comparison between **Basic Rate Interface (BRI)** and **Primary Rate Interface (PRI)** configurations?

## Relationship X.25 and PCM

In the architecture of ISDN networks, **X.25 and Pulse-Code Modulation (PCM)** represent entirely different layers of the telecommunications stack, but they directly rely on each other to deliver integrated voice and data services.

The relationship between them can be best understood through their distinct functions and how they intersect within ISDN's channel architecture.

### 1. The Functional Split: Physical Transport vs. Data Protocol

- **PCM is the physical reality (Layer 1):** It is a hardware-level modulation technique used to convert analogue signals (like human speech) into a raw digital stream of bits. In telecommunications, the standard **ITU-T G.711** dictates that speech is sampled 8,000 times per second at an 8-bit depth.
- $8,000 \text{ samples/sec} \times 8 \text{ bits/sample} = 64 \text{ Kbps}$
- This specific math created the fundamental **64 Kbps standard unit of bandwidth** (known as a DS0 channel) that dictated the speed of all legacy digital telecommunications.
- **X.25 is the logical protocol (Layers 2 & 3):** X.25 is an early packet-switching protocol suite. It does not care *how* a bit is physically transmitted over a wire; instead, it defines how data is chopped into packets, addressed, error-checked, and routed across a data network.

### 2. How They Meet Inside the ISDN Pipe

ISDN brought these two distinct pieces of technology together by splitting its copper-wire bandwidth into distinct logical channels: **B-Channels** (Bearer) and **D-Channels** (Delta).

#### The B-Channels (Bearer Channels)

- Each B-channel runs at exactly **64 Kbps**, an intentional architectural decision engineered specifically to fit one raw, uncompressed PCM voice stream natively.

- When you made a standard phone call over ISDN, your voice was digitized via **PCM** and passed directly over the B-channel.
- However, if you wanted to send digital packet data rather than voice, ISDN could encapsulate **X.25 data packets** inside that same 64 Kbps B-channel pipeline, transparently routing it to an external packet-switched data network.

#### The D-Channel (Data/Signalling Channel)

- The D-channel (running at 16 Kbps or 64 Kbps depending on the setup) was primarily used for call signalling—like telling the network to ring a far-end phone.
- Because signalling doesn't require constant bandwidth, the D-channel frequently sat idle. ISDN designers leveraged this by allowing users to transmit low-speed **X.25 packet data** over the D-channel simultaneously.
- This meant businesses could run credit card validation or telemetry data via X.25 over the D-channel without tying up their primary PCM voice/data B-channels.

#### Direct Comparison

| Feature         | Pulse-Code Modulation (PCM)                              | X.25 Protocol                                                       |
|-----------------|----------------------------------------------------------|---------------------------------------------------------------------|
| OSI Layer       | Layer 1 (Physical/Hardware level)                        | Layers 2 & 3 (Data Link & Network level)                            |
| Primary Purpose | To digitize analogue voice frequencies into binary data. | To structure, route, and error-correct data packets.                |
| Switching Type  | Circuit-Switched (Dedicated timeslots/bandwidth).        | Packet-Switched (Shared lines, bursty data traffic).                |
| ISDN Role       | Defined the 64 Kbps bit-rate sizing for B-channels.      | Provided the protocol to send data text/files over B or D channels. |

**In short:** PCM created the raw digital 64 Kbps highways (channels) out of old copper telephone lines, while X.25 acted as one of the major vehicular traffic laws used to organize and safely transport data packages across those exact highways.

### What were normal Telecom / Telstra fees monthly?

In the 1990s, deploying an ISDN line in Australia through Telecom (which rebranded to Telstra in 1995) was considered a premium enterprise-grade networking option. The pricing structure was deliberately high, split between **hefty fixed monthly rentals** and **metered usage tariffs** that made prolonged connections financially punitive.

Historical monthly fees and tariff models for Telstra's flagship **OnRamp** services reveal the substantial costs involved:

#### 1. Fixed Monthly Rental Fees

These were the recurring "line rental" fees just to keep the service active. They did not include internet service provider (ISP) fees or the actual cost of calls.

- **OnRamp 2 (ISDN BRI - 2x 64 Kbps Channels):**
  - **Monthly Rental:** Typically **\$60 to \$80 per month** in the mid-to-late 1990s.
  - By comparison, a standard analogue residential or small-business telephone line (POTS) line rental was roughly \$15 to \$20 per month.
  - *Note:* Telstra later launched a heavily restricted "OnRamp Home Highway" bundle targeting early internet adopters in the late 90s/early 2000s, which attempted to ease this rental cost but bound users to highly specific ISP parameters.
- **OnRamp 30 (ISDN PRI - 30x 64 Kbps Channels):**
  - **Monthly Rental:** Roughly **\$800 to \$1,200+ per month**, depending on the contract term and location.
  - This was strictly the domain of large corporations, universities, and early ISPs setting up "modem pools" to accept dial-up traffic from the general public.

## 2. The Real Killer: Call Costs and Usage Tariffs

What made 1990s Australian ISDN notoriously expensive was that **data calls were treated differently from voice calls**.

- **The 30c Local Call vs. Metered Data:** While standard analogue telephone lines enjoyed flat-rate untimed local calls (around 25 cents in the 90s), Telstra initially billed ISDN data transmissions **by the minute per channel** if you were dialing outside their preferred nodes.
- **Per-Hour Costs:** If an explicit data connection was made to an external ISP, users were often hit with line usage fees of **\$1.10 to over \$2.00 per hour, per channel**. If a business bonded both B-channels to achieve a blazing-fast 128 Kbps, the clock ran twice as fast.
- **The "Data Over Voice" (DoV) Loophole:** Because of these steep metered data rates, a famous tech workaround emerged in Australia. If an administrator could configure their ISDN routers to flag a data call as a *voice* call over the network, Telstra's exchange would mistakenly bill it as a flat-rate local call instead of a per-minute data call. Telstra fought hard against DoV, frequently patching exchange software to block it.

## 3. T1 / Leased Line Alternatives (Permanent Links)

For large corporate headquarters that could not afford timed call metrics, a dedicated digital leased line was the alternative:

- **56K DDS (Digital Data Service):** A permanent, always-on 56 Kbps link. This routinely cost **\$300 to \$600+ per month** just for the point-to-point physical tail.
- **Full T1 / E1 (1.5 Mbps to 2.0 Mbps):** Permanent leased lines at these speeds were astronomically expensive. A dedicated 1.5 Mbps link in the mid-90s routinely cost **thousands of dollars per month** (often between \$2,000 and \$5,000/month depending on distance to the exchange), which is why they were solely reserved for primary university hubs, major banks, or the upstream feeds of regional ISPs.

## Total Cost Summary (1990s Corporate Perspective)

For a medium-sized Australian business in 1997 wanting a basic **OnRamp 2 (128 Kbps)** internet connection for an office of 20 people, the entry-level budget looked like this:

| Expense Item                                         | 1990s Cost Estimate (AUD)             |
|------------------------------------------------------|---------------------------------------|
| <b>Upfront ISDN Installation</b>                     | ~\$300 – \$500                        |
| <b>Cisco 2503 Router</b>                             | ~\$2,500 – \$4,000                    |
| <b>Telstra OnRamp Line Rental</b>                    | ~\$75 / month                         |
| <b>Metered Call Usage (if unbundled)</b>             | ~\$200 – \$600 / month                |
| <b>Corporate ISP Subscription (Quota/Access Fee)</b> | ~\$300 – \$800 / month                |
| <b>Total Ongoing Cost:</b>                           | <b>~\$600 to \$1,500+ every month</b> |

This cost barrier is exactly why small businesses stuck to standard 33.6K or 56K analogue modems using flat-rate untimed local phone calls until Telstra was forced to roll out unmetered cable and early ADSL options around the turn of the millennium.

## Did ISDN in Australia in 1989 use the standard copper phone line at each residence

**Yes, ISDN in Australia did utilize the standard copper wire telephone network** to deliver its digital services. However, there is a major catch regarding *where* it was used in 1989: **it was not available at typical residences.**

### The Copper Connection

Integrated Services Digital Network (ISDN) was intentionally designed to run over the existing "last-mile" copper infrastructure—known in telecommunications as the **Customer Access Network (CAN)** or local loops—running from local telephone exchanges to customer premises. Instead of carrying traditional analogue signals (POTS), it used digital transmission equipment to split that same copper line into multiple digital channels.

### The 1989 Availability Reality

When Telecom Australia (which later became Telstra) officially switched on the country's first national commercial ISDN service on **July 1, 1989**, it was strictly configured as an elite enterprise product:

- **Macrolink (Primary Rate ISDN):** This was the initial product launched in July 1989. It was pitched squarely at big banks, government departments, and massive corporate Private Automatic Branch Exchanges (PABXs). It delivered high-capacity digital pipelines (usually up to 30 channels over specialized ties), which were far beyond the infrastructure or needs of a standard house.
- **Microlink (Basic Rate ISDN):** Telecom Australia rolled out "Microlink" soon after for smaller businesses. This version used a single standard copper pair to provide two 64 kbps data channels (known as 2B+D).

While Microlink mathematically *could* work over a household's standard copper phone line, Telecom Australia priced and marketed ISDN as a premium commercial service. Because of exorbitant installation costs, monthly rental fees, and specialized equipment requirements, residential consumers in 1989 still relied entirely on standard analogue dial-up or early videotex systems like Viatel. It wasn't until the mid-to-late 1990s that heavy residential internet users or home offices began adopting Basic Rate ISDN lines.

## How did those 30 channels over specialized ties work

The 30-channel Macrolink system rolled out by Telecom Australia in 1989 worked using a European telecommunications standard known as an **E1 carrier line** running a **Primary Rate Interface (PRI)**.

Instead of treating the copper connection like a single pipe for one conversation, it chopped a high-capacity digital line into microscopic slices of time to carry dozens of calls simultaneously.

### 1. The Physical "Specialized Ties"

To deliver 30 channels, standard residential telephone lines weren't enough. Telecom Australia provisioned specialized corporate "ties" using a **four-wire setup** or high-grade coaxial cables rather than a standard two-wire residential loop.

- **Separated Traffic:** Two wires were dedicated strictly to transmitting data, and two wires were dedicated strictly to receiving data.
- **No Interference:** By physically separating the "talk" and "listen" paths, the system bypassed the echo cancellation and signal-splitting issues that limited standard household lines, allowing for a much cleaner, higher-frequency digital signal.

### 2. Time Division Multiplexing (TDM)

The core magic of how 30 channels squeezed onto those wires is a technique called **Time Division Multiplexing (TDM)**.

The system didn't separate the channels by frequency (like radio stations). Instead, it gave every single channel a **strict, recurring slot in time**. The E1 line had a total raw bandwidth of **2.048 Mbps**, which it split evenly into **32 distinct time slots** (numbered 0 to 31). Each individual time slot stream ran at exactly **64 kbps**.

The hardware threw data down the line in sequential cycles (frames). It would send 8 bits of data for Channel 1, then 8 bits for Channel 2, ticking through all 32 slots before looping back to Channel 1. This happened **8,000 times per second**, so fast that to the human ear or a data terminal, all 32 streams seemed entirely continuous and independent.

### 3. The 30B + 2D Channel Breakdown

While there were 32 physical time slots available on the wire, they weren't all used for phone calls. Telecom Australia mapped them out using a system called **30B+2D** (or more technically, 30B+1D+1 Synchronization):

- **30 B-Channels (Bearer Channels):** Time slots 1 through 15 and 17 through 31 were the worker bees. Each **B-Channel** carried the actual payload—either a digitized human voice call or raw computer data. Because they were purely digital, a corporate PABX (the company's

internal telephone switchboard) could dynamically assign these channels on the fly. If 20 employees were on the phone and a fax machine started up, the system just routed the fax data through slot 21.

- **1 D-Channel (Data/Signalling Channel):** Time slot 16 was strictly reserved for the **D-Channel**. In older analogue systems, the sounds of touch-tones or dialing happened on the same line as the call. ISDN changed this by taking all "signalling" off-channel. Slot 16 handled the data packet instructions for the entire line: *"Hey, an incoming call is trying to reach extension 204,"* or *"Hang up the call on Channel 5."* Because the D-channel handled the paperwork in its own separate lane, calls connected almost instantly.
- **1 Framing/Synchronization Channel:** Time slot 0 was used by the phone company's exchange equipment for alignment and maintenance. It carried a continuous pattern of bits so the receiving equipment on the corporate end could precisely sync its clock and accurately identify exactly where "Time Slot 1" began.

#### 4. Aggregating for "Fatter" Pipes (H-Channels)

For massive corporate networks or early video conferencing setups, companies didn't have to use these 30 channels individually for voice.

The Macrolink system allowed businesses to "bond" or glue multiple B-channels together into a single high-speed pipeline called an **H-Channel**. For example, a company could bind 6 channels together to create an **H0 channel running at 384 kbps** to smoothly transmit high-fidelity audio or early digital video between interstate corporate offices.

Would you like to know more about the **hardware** that sat on the corporate customer's premises to manage this (like the **NT1 / NT2 network terminators**), or how this **2.048 Mbps Australian E1 standard** differed from the T1 standard used in America?

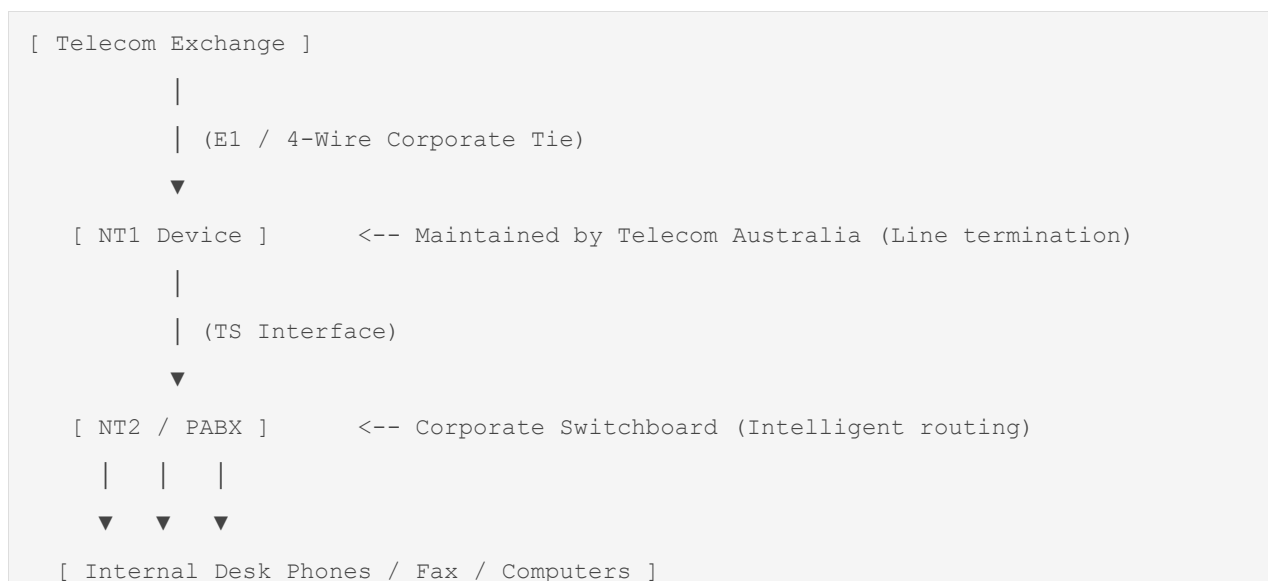
## Both

To see how Australia's enterprise ISDN system operated, we have to look at both the physical hardware that sat inside the corporate server rooms and the global battle of telecommunications standards that divided Australia from the United States.

Here is how the customer hardware functioned and how the **Australian E1 standard** compared to the **American T1 standard**.

#### Part 1: The On-Premises Hardware (NT1, NT2, and PABX)

For a business in 1989 to actually use those 30 channels, Telecom Australia couldn't just plug the wires straight into a phone. The digital signals required a strict hierarchy of equipment on the customer's premises to translate the raw bitstream into usable office phone lines.



- **The NT1 (Network Termination 1):** This was a rugged piece of hardware installed at the boundary of the customer's property. The NT1 was legally the property of Telecom Australia. Its sole job was electrical and physical: it terminated the 4-wire line coming from the street, handled power management, performed loopback diagnostics for the phone company, and converted the long-distance transmission signals into a clean local interface (known as the *T-interface*).
- **The NT2 (Network Termination 2):** Unlike the NT1, the NT2 was an intelligent device usually owned by the customer. In a 30-channel Macrolink setup, the NT2 was almost always embedded directly into a corporate **PABX (Private Automatic Branch Exchange)**—a massive, computerized telephone switchboard cabinet sitting in the server room.
- **The PABX Allocation:** The PABX was the "brain." It accepted the 2.048 Mbps stream from the NT1 and dynamically carved up the 30 B-channels. If a customer dialed the company's main number, the PABX intercepted the instructions on the D-channel (Time Slot 16), picked an open B-channel, and routed that specific time slot's data directly to the receptionist's desk phone.

## Part 2: E1 (Australia) vs. T1 (USA)

When digital telephony emerged, the world split into two distinct standards. Australia, aligning with European CCITT (now ITU-T) standards, adopted the **E1** system. The United States, Canada, and Japan adopted the **T1** system (developed by Bell Labs).

The differences between the two impacted everything from total bandwidth to how phone calls actually sounded.

| Feature          | Australian / European E1 (Macrolink) | American T1 (Primary Rate ISDN) |
|------------------|--------------------------------------|---------------------------------|
| Total Bandwidth  | 2.048 Mbps                           | 1.544 Mbps                      |
| Total Time Slots | 32 slots                             | 24 slots                        |

| Feature                    | Australian / European E1 (Macrolink)               | American T1 (Primary Rate ISDN)                              |
|----------------------------|----------------------------------------------------|--------------------------------------------------------------|
| Usable Voice/Data Channels | 30 B-Channels                                      | 23 B-Channels                                                |
| Signalling (D-Channel)     | Dedicated lane (Slot 16). Out-of-band.             | Dedicated lane (Slot 24). Out-of-band.                       |
| Framing & Sync             | Dedicated lane (Slot 0).                           | Borrowed bits (1 framing bit added per frame).               |
| Voice Quality Encoding     | A-law (Higher dynamic range, clearer low volumes). | $\mu$ -law (Mu-law) (Slightly different compression curves). |

### Why Australia's E1 Was Superior

1. **More Raw Capacity:** Because an E1 line utilized 32 slots instead of 24, an Australian corporate tie could handle **30 simultaneous calls**, whereas an American T1 line could only handle **23 calls**.
2. **Clean "Out-of-Band" Design:** In an E1 system, synchronization (Slot 0) and dialling data (Slot 16) were kept entirely separate from the 30 voice channels. In early American T1 networks, the system frequently had to perform "robbed-bit signalling," meaning it would occasionally steal tiny fragments of audio data from the voice channels to pass routing information. This made American T1 lines notoriously difficult to use for pure, uncorrupted computer data transmission until strict ISDN primary rate configurations were applied later on.
3. **The Audio Processing (A-law):** The mathematical algorithm used by Australian exchanges to turn a human voice into digital 1s and 0s (A-law) handled quiet background sounds and lower volumes slightly better than the American equivalent ( $\mu$ -law).

Because Australia built its network on the E1 standard, an enterprise Macrolink connection in 1989 was incredibly robust, allowing businesses to link corporate data networks across states at speeds that American companies needed multiple expensive T1 lines to replicate.

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