Cisco − E1 R2 Signaling Theory

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Introduction

R2 signaling is a channel associated signaling (CAS) system developed in the 1960s that is still in use today in Europe, Latin America, Australia, and Asia. R2 signaling exists in several country versions or variants in an international version called Consultative Committee for International Telegraph and Telephone (CCITT−R2). The R2 signaling specifications are contained in International Telecommunication Union International Telecommunication Union Telecommunication Standardization Sector (ITU−T) Recommendations Q.400 through Q.490.

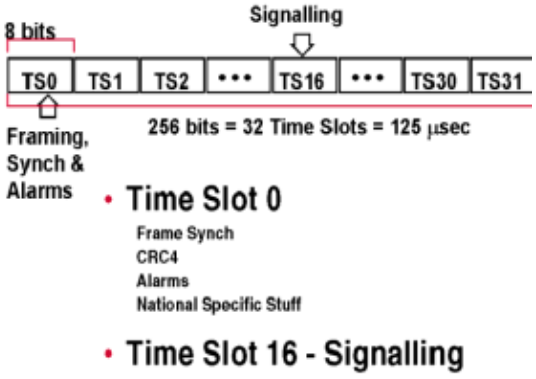
E1 R2 signaling is an international signaling standard that is common to channelized E1 networks. E1 R2 signaling has been supported on the Cisco AS5200, 5300, and 5800 series access routers. E1 R2 signaling was introduced to the Cisco 2600/3600 series routers in Cisco IOS® Software Release 12.1.2XH, and 12.1(3)T.

Note: R2 signaling is not supported on the Cisco MC3810 router.

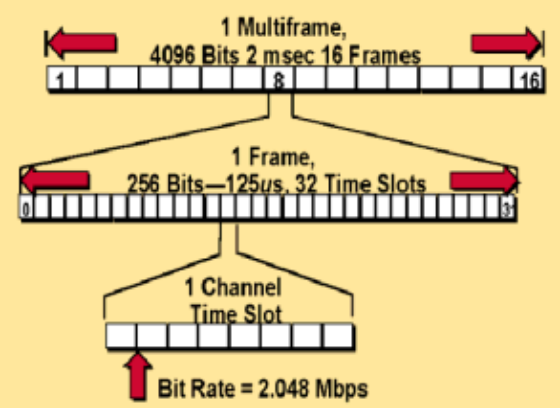
E1 R2 signaling support allows the Cisco AS5x00s and Cisco 2600/3600 series routers to communicate with a central office (CO) or private branch exchange (PBX) trunk and act as a tie−line replacement. Although R2 signaling has been defined in ITU−T Q.400−Q.490 recommendations, there are many variations in how R2 is implemented. (Various countries have selected to implement R2 differently.) Cisco's implementation of R2 signaling on routers is able to address this issue to accommodate most of the countries in the world.

E1 Digital Facilities

R2 signaling operates across E1 digital facilities. The E1 digital facilities carrier runs at 2.048 Mbps and has 32 time−slots. E1 time−slots are numbered TS0 to TS31, where TS1 through TS15 and TS17 through TS31 are used to carry voice which is encoded with pulse code modulation (PCM), or to carry 64 kbps data. The drawing below shows the 32 time−slots of an E1 frame.



An E1 carrier can use a multiframe structure within a Super Frame (SF) format or it can run in a non−multiframe mode without cyclic redundancy check (CRC). The SF format contains 16 consecutive frames numbered 0 to 15. Time−slot TS16 in frame 0 is used for SF alignment, and TS16 in the remaining frames (1−15) is used for CAS trunk signaling. TS16 uses 4 status bits designated as A, B, C, and D for signaling purposes. This multiframe structure is used for CRC, or error checking. This 16−frame multiframe structure (SF) allows a single 8−bit time slot to handle the line signaling for all 30 data channels. The following diagram illustrates the E1 SF format.



R2 Signaling

There are two elements to R2 signaling: Line Signaling (supervisory signals) and Interregister Signaling (call setup control signals). Most country variations in R2 signaling are with the Interregister Signaling configuration.

Line Signaling (Supervisory Signals)

You can use line signaling, which uses TS16 (bits A B C D), for supervisory purposes such as handshaking between two offices for call setup and termination. In the case of CCITT−R2 signaling, only bits A and B are used (bit C is set to 0 and bit D is set to 1). For two−way trunks, the supervision roles for forward and backward signaling vary on a call−by−call basis. The following table illustrates the R2 supervision signal, transition, and direction used on digital trunks.

An idle state is denoted when when A=1 and B=0.

Direction	Signal Type	Transition

Forward	Seizure	A,B: 1,0 to 0,0
Forward	Clear−forward	A,B: 0,0 to 1,0
Backward	Seizure Acknowledgment (ACK)	A,B: 1,0 to 1,1
Backward	Answer	A,B: 1,1 to 0,1
Backward	Clear−back	A,B: 0,1 to 1,1
Backward	Release−guard	A,B: 0,1 to 1,0

Line signaling is defined with the types shown below:

- **R2−Digital** − R2 Line Signaling type ITU−U Q.421, typically used for PCM systems (where A and B bits are used).
- **R2−Analog** − R2 Line Signaling type ITU−U Q.411, typically used for carrier systems (where a Tone/A bit is used).
- **R2−Pulse** − R2 Line Signaling type ITU−U Supplement 7, typically used for systems that employ satellite links (where a Tone/A bit is pulsed).

Note: R2−Pulse reflects the same states as the analog signaling but the analog signal is a steady state (continuous signal) while the pulsed signal stays on only for a short duration. Pulsed is just a single pulse to reflect the state change.

For more information on configuring line signaling refer to the **E1 R2 Signaling Configuration** document.

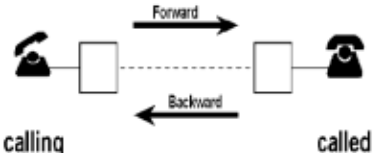
Interregister Signaling (Call Setup Control Signals)

The concept of address signaling in R2 is slightly different from that used in other CAS systems. In R2 signaling, the exchanges are considered registers and the signaling between these exchanges is called inter−register signaling. Inter−register signaling uses forward and backward *in−band* multifrequency signals in each time−slot to transfer called and calling party numbers, as well as the calling party category.

Note: Some countries use two−out−of−six in−band dual tone multifrequency (DTMF) instead of forward and backward in−band multifrequency signals.

Multifrequency signals used during the Interregister Signaling are divided in forward signal groups (I and II), and backward signal groups (A and B). Interregister signaling starts after the 'Seize−ACK' of the line. The diagram and table below illustrate forward and backward signal information.

- Forward: towards the called party
- Backward: towards the calling party



Forward Signal Groups	Backward Signal Groups

Group−I Signals • Represent the called party number or dialed digits • DNIS/ANI digits. • I−1 to I−10 are digits 1 to 10. • I−15 is the end of identification. **Group−II Signals** • Represent the calling party category • II−1 is subscriber without priority. • II−2 to II−9 are subscriber with priority. • II−11 to II−15 are spare for national use.	**Group−A Signals** • Indicate if the signaling ended or if a particular forward signal is required. • Used to acknowledge and convey signaling information • A−1 is send next digit. • A−3 is address−complete, changeover to reception of Group−B signals. • A−4 is congestion. • A−5 is send calling party's category. • A−6 is address complete, charge, setup, speech conditions. **Group−B Signals** • Sent by the terminating switch to acknowledge a forward signal, or to provide a call charging and called party information. • Used to acknowledge Group−II forward signals. This is always preceded by an address−complete signal A−3. • B−3 is subscriber line busy. • B−4 is congestion. • B−5 is unallocated number. • B−6 is subscriber's line free charge.

The following inter−register group sequence rules are used to identify the signal's group:

- The initial signal received by the incoming exchange is a Group I signal
- Outgoing exchanges consider backward signals as Group A signals
- Group A signals received by outgoing exchanges are used to identify whether the next signal is a Group B signal
- Group B signals always indicate and end−of−signaling sequence

There are three types of Interregister Signaling shown below:

- **R2−Compelled** − When a tone−pair is sent from the switch (forward signal), the tones stay on until the remote end responds/ACK back with a pair of tones that signals the switch to turn off the tones. The tones are compelled to stay on until they are turned off.

- **R2−Non−Compelled** − The tone−pairs are sent (forward signal) as pulses so they stay on for a short duration. Responses (backward signals) to the switch (Group B) are sent as pulses. There are no Group A signals in non−compelled interregister signaling.
  Note: Most installations use the Non−Compelled type of Interregister Signaling.

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R2−Semi−Compelled − Forward tone−pairs are sent as compelled. Responses (backward signals) to the switch are sent as pulses. It is the same as compelled, except that the backward signals are pulsed instead of continuous.

Note: Do not use compelled signaling on slow (satellite) links. The call setup time would be too great because of distance delays.

Most country−specific variations of R2 signaling are seen in the interregister signaling. Unique E1 R2 signaling parameters for specific countries and regions are set by entering the command **cas−custom**, followed by the command **country name**.

For more information on configuring Interregister Signaling and **cas−custom** command parameters refer to the **E1 R2 Configuration and Troubleshooting** document.

Related Information

- **E1 R2 Configuration and Troubleshooting**
- **E1 R2 Signaling for the Cisco AS5300 and Cisco AS5200 Access Servers**
- **E1 R2 Signaling for the Cisco 3620 and 3640 Series Routers**
- **E1 R2 Signaling for the Cisco AS5800**
- **Packet Voice, Video and Telephony Technical Tips**
- **Telephony Signaling Technical Tips**
- **Voice and Telephony Technology Support Pages**

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