The foundation of network security is router security.
1) Router security within a general IT security plan, IOS software and standard access.

2) Password security and authentication.

3) Services, applications and protocol security.

4) NTP, logging and incident response.
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Risk Analysis.

\[ R = v(1..n) \times t(1..n) \times c(1..n) \]

Where \( R \) = total risk cost, \( t \) = threat, \( v \) = vulnerability, and \( c \) = cost.
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Physical Security.

Think like a jealous Greek god. Or a resistentialist.

Think like a burglar.

No modems on the console port.
Legal Security.

MOTD banners; the apocryphal “Welcome” message.

Protect against intruders, liability, warn about monitoring and acceptable use policies. Use implies consent.
Secure the IOS.

Every IOS has security problems. Keep yours up-to-date.

Only GD (General Deployment) releases should be deployed.
Router Access.

Many ways to access a Cisco router, with variations in authorization; the console port, the auxiliary port, or network access through virtual TTYs (VTYs).

It is recommended that one of the five VTY passwords is kept different from the other four.
Authentication and VTY/AUX Access.

Ensure that login names are required.

If VTY and AUX ports are not used then they should be disabled.
Router(config)#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#line aux 0
Router(config-line)#login local
Router(config-line)#no password
Router(config-line)#transport input none
Router(config-line)#no exec
Router(config-line)#exec-timeout 0 1
Router(config-line)#^Z
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Using NAS and TFTP.

Network Access Servers are an easier alternative to local usernames. Use TACACS+, RADIUS or Kerberos.

Configuration files on TFTP servers and routers as TFTP servers is significant risk.
Remote Administration.

Basic methods are AUX, VTY and HTTP. Common dangers include sniffing, brute-force attacks, spoofing of source IP address, hijacking sessions, and compromise of trusted hosts. Don't use Telnet. Secure VTY. Use callback security. Disable HTTP access ('no ip http server' at global configuration).
Passwords and Services.

Use 'password-encryption' from global configuration for user level. Privileged level passwords should be set with the 'enable secret' command. Different routers should have different passwords and backup configurations should be kept on secure servers. Services, such as connect, telnet, rlogin, show ip access-lists etc should be reconfigured.
Selective ICMP packets should be disabled; on every interface ICMP redirects, broadcasts, mask replies, unreachables, and proxy ARPs. This is achieved through the 'no ip redirects','no ip directed-broadcast','no ip mask-reply','no ip unreachables'and 'no ip proxy-arp' commands.
Further, ICMP Timestamp and Information Requests should be blocked by an ACL to protect against network mapping by an attacker. e.g.,

```
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#access-list 101 deny icmp any any timestamp-request
Router(config)#access-list 101 deny icmp any any information-request
Router(config)#access-list 101 permit ip any any
Router(config)#interface serial 0/0
Router(config-if)#ip access-group 101 in
Router(config-if)#^Z
Router#
```
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Other Services.

The following services should also be disabled (all at global config):

Source routing ('no service source-route'), small services ('no service tcp-small-servers', 'no service udp-small-servers') and finger ('no service finger' or 'no ip finger' on newer version of the IOS).
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CDP and Proxy ARP.

Make your network map. Then disable CDP, either globally ('no cdp run') or locally per interface ('no cdp enable'). Disable Proxy ARP on each interface ('no ip proxy-arp')
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Optionally.

Disable (all at global config) BootP, DNS, Network autoloading of configuration files, PAD, IP classless.
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SNMP.

Either disable or secure.

Especially dangerous with R/W Access and TFTP.

Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#snmp-server community StrongStringReadOnly RO
Router(config)#^Z
Spoofing.

Prevented by ingress and egress filters.

Cisco has developed Unicast Reverse Packet Forwarding (uRPF)
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To enable uRPF, you must first globally enable CEF, and then uRPF on each needed interface:

Router#config terminal
Enter configuration commands, one per line.  
   End with CNTL/Z.
Router(config)#ip cef
Router(config)#interface Serial 0/1
Router(config-if)#ip verify unicast reverse-path
Router(config-if)#^Z
Routing Authentication.

Available on RIP2, OSPF, EIGRP, and BGP.

Minor differences on each protocol.
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RIPv2 example:

RouterOne#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
RouterOne(config)#interface FastEthernet 0/0
RouterOne(config-if)#ip rip authentication key-chain 20
RouterOne(config-if)#ip rip authentication mode md5
RouterOne(config-if)#exit
RouterOne(config)#interface Serial 0/0
RouterOne(config-if)#ip rip authentication key-chain 20
RouterOne(config-if)#ip rip authentication mode md5
RouterOne(config-if)#exit
RouterOne(config)#^Z
RIPv2 example cont:

Next, the key chain 20 is defined. Inside key chain 20, key number 1 is created with the string StrongPassword:

RouterOne#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
RouterOne(config)#key chain 20
RouterOne(config-keychain)#key 1
RouterOne(config-keychain-ke)#key-string StrongPassword
RouterOne(config-keychain-ke)#^Z
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NTP.

Necessary for auditing purposes etc.

Different configuration options. Redundancy. Use ACLs and NTP authentication.
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Logging.

Console logging, buffered logging, terminal logging, syslog, SNMP traps, ACL logs.

AAA accounting (exec, system, command, connection, network).
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To configure your router to send log messages to the server 10.0.0.1 using facility local6 and severity informational:

RouterOne#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
RouterOne(config)#logging facility local6
RouterOne(config)#logging trap informational
RouterOne(config)#logging 10.0.0.1
RouterOne(config)#^Z