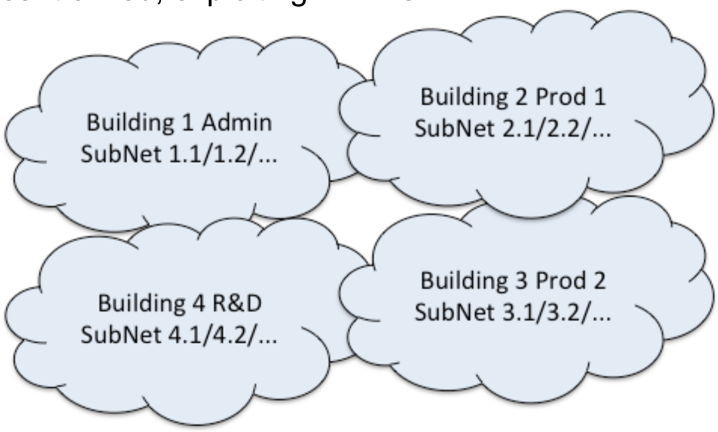
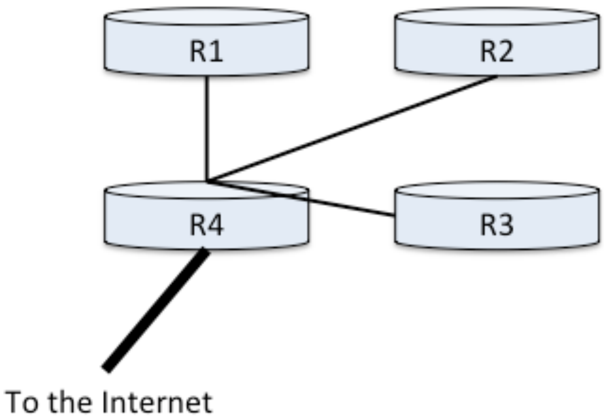
Advanced Networking

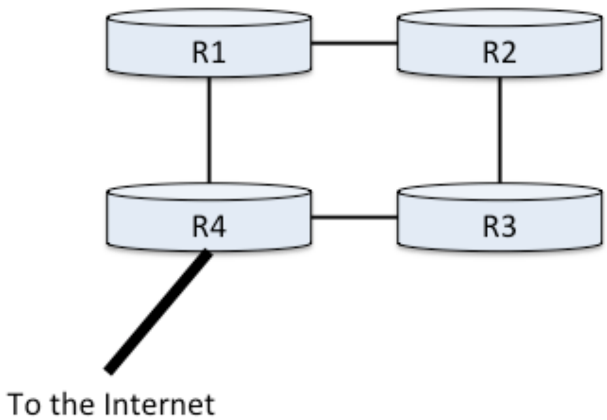
Solution hints and examples

The logical topology of the network is naturally mapped to the four buildings as in the following picture. Most logically each building corresponds to one or more IP subnets properly interconnected at the IP level. DHCP services can be local to each building or centralized, exploiting VLANs.



Each building will be connected to the campus LAN through a Router or Layer 3 Switch. The interconnection can be done either with a star topology, simplifying some routing issues, or, better in a ring topology guaranteeing redundancy and reliability. The two options are shown below, left and right respectively. Let's assume that the Internet connection is from Building 4, the one dedicated to R&D.





As far as addresses are concerned, there is no reason to use public IP addresses for all PCs and for VoIP devices in particular, while the servers reachable from the outside must have public IP addresses, and bust be conveniently shielded with firewalls both from the internal and from the external accesses.
A range of public IP addresses /24 should be sufficient for all needs of the company. It can be conveniently split into four /26 subnets, one dedicated to public servers, one dedicated

to R&D servers (in the hypothesis that there are R&D servers separated from the commercial ones), one dedicated to NAT translation and finally one spared for additional uses. The internal routers need not have public IP addresses and will use IP addresses taken from the private subnets.
Given the presence of more than 5000 IP devices we need at least 2000 IP addresses per building. The easiest way is to use standard 168.192.x.0/24 subnet, adding addresses as needed in each building LAN. In any case it is advisable to maintain different employee roles and different devices in different subnets.
For example, assuming in Building 1 there are 150 managers

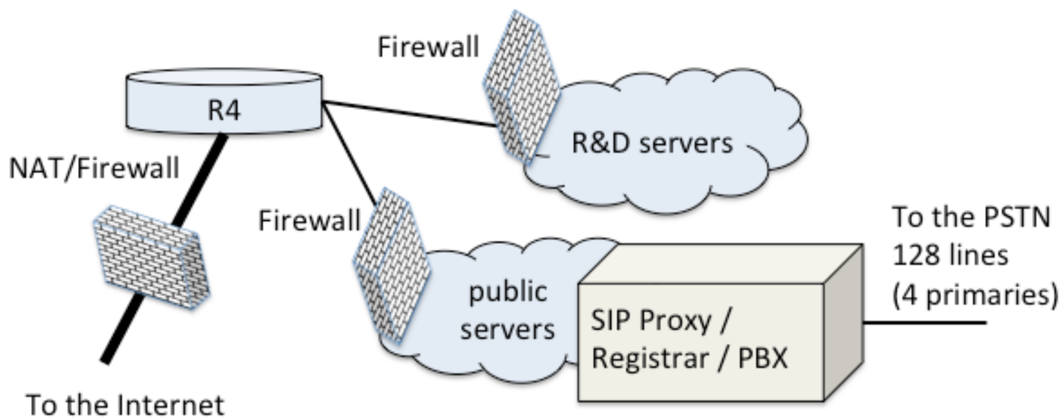
- LAN1.1, Managers' PC: 168.192.1.0/24
- LAN1.2, Admins' PC: 168.192.2.0/24
- LAN1.3, Admins' PC: 168.192.3.0/24
- LAN1.4, Managers' VoIP: 168.192.128.0/24
- LAN1.5, Admins' VoIP: 168.192.129.0/24
- LAN1.6, Admins' VoIP: 168.192.130.0/24

Additionally one may think of WiFi access for mobility, and for potential guests, so some more subnets may be added, for example

- WLAN1.7, Managers' WiFi: 168.192.64.0/24
- WLAN1.8, Managers' WiFi: 168.192.65.0/24
- WLAN G, Managers' WiFi: 168.192.255.0/24

Assuming guests will not be many a single VLAN and subnet can be dedicated to them across all buildings.

Coming to the configuration of servers and Internet access it is convenient that the Internet is accessed through a NAT/Firewall device, but also that servers are separated by the Company network by another firewall, effectively defining a "secure" zone where the servers are connected. Among servers, we have to dedicate some special attention to the SIP Proxy serving VoIP calls. Assuming again that the company Data Center is located in Building 4, the figure below sketches a high level logical design of this part of the network.



The VoIP services can interconnect the company system to other VoIP systems through the standard Internet access, but they must be interconnected to the traditional PSTN for global service. 128 lines of interconnection can be a good dimension for this part:

approximately 1 every 20 employees.
Given the nature of the company, a 1Gibt/s Internet access is the minimum. It can also be realized with a 10Gbit/s Ethernet link, and then only a part of it is used, but service can be increased dynamically without the need of changing devices.
The internal backbone (links connecting buildings) should be at 10Gbit/s.

Note: this solution sketch is definitely enough to pass the written exam, but it is far from complete or "optimal" or the only one. Details can be given on the internal routing protocol, on the necessity (or not) to have an exterior routing protocol, etc. A different network layout, with dual homing can be conceived, e.g. separating R&D Internet access from the others (what are the consequences?). Hypotheses on the servers/services to be supported can be given, expanding the relative discussion, and many other "directions" can be taken.