

**Міністерство освіти і науки України  
Карпатський національний університет  
імені В.Стефаника**

Факультет математики та інформатики  
Кафедра інформаційних технологій

**Хмарні технології**

**Практична робота №4**

**Тема:** Implement Virtual Networking

**Мета:** Навчитися основам роботи з віртуальними мережами

Виконав: Андрусяк І.Р.  
Група ІІЗ-41  
Дата: 1 грудня 2025р.  
Викладач: Поварчук Д.Д.

## Task 1: Створення CoreServicesVnet з підмережами providers.tf

```
1  terraform {
2    required_version = ">= 1.0"
3    required_providers {
4      azurerm = {
5        source = "hashicorp/azurerm"
6        version = "~>3.0"
7      }
8    }
9  }
10
11 provider "azurerm" {
12   features {}
13 }
```

## main.tf

```
1  resource "azurerm_resource_group" "rg" {
2    name      = var.resource_group_name
3    location  = var.location
4    tags      = var.tags
5  }
6
7  resource "azurerm_virtual_network" "core_vnet" {
8    name                = var.core_vnet_name
9    location             = azurerm_resource_group.rg.name string
10   resource_group_name = azurerm_resource_group.rg.name
11   address_space       = var.core_vnet_address_space
12   tags                = var.tags
13 }
14
15 resource "azurerm_subnet" "core_subnets" {
16   for_each = var.core_subnets
17
18   name                = each.value.name
19   resource_group_name = azurerm_resource_group.rg.name
20   virtual_network_name = azurerm_virtual_network.core_vnet.name
21   address_prefixes    = each.value.address_prefixes
22 }
```

## outputs.tf

```

1  output "resource_group_name" {
2      description = "Name of the resource group"
3      value       = azurerm_resource_group.rg.name
4  }
5
6  output "resource_group_id" {
7      description = "ID of the resource group"
8      value       = azurerm_resource_group.rg.id
9  }
10
11 output "core_vnet_name" {
12     description = "Name of the Core Services VNet"
13     value       = azurerm_virtual_network.core_vnet.name
14 }
15
16 output "core_vnet_id" {
17     description = "ID of the Core Services VNet"
18     value       = azurerm_virtual_network.core_vnet.id
19 }
20
21 output "core_vnet_address_space" {
22     description = "Address space of Core Services VNet"
23     value       = azurerm_virtual_network.core_vnet.address_space
24 }
25
26 output "subnet_ids" {
27     description = "IDs of the subnets"
28     value       = { for k, v in azurerm_subnet.core_subnets : k => v.id }
29 }
30
31 output "subnet_names" [
32     description = "Names of the subnets"
33     value       = { for k, v in azurerm_subnet.core_subnets : k => v.name }
34 ]

```

**variables.tf**

```

1  variable "resource_group_name" {
2      description = "Name of the resource group"
3      type        = string
4      default     = "az104-rg4"
5  }
6
7  variable "location" {
8      description = "Azure region"
9      type        = string
10     default     = "East US"
11 }
12
13 variable "core_vnet_name" {
14     description = "Name of the Core Services VNet"
15     type        = string
16     default     = "CoreServicesVnet"
17 }
18
19 variable "core_vnet_address_space" {
20     description = "Address space for Core Services VNet"
21     type        = list(string)
22     default     = ["10.20.0.0/16"]
23 }
24
25 variable "core_subnets" {
26     description = "Subnets for Core Services VNet"
27     type = map(object({
28         name           = string
29         address_prefixes = list(string)
30     }))
31     default = {
32         shared = {
33             name           = "SharedServicesSubnet"
34             address_prefixes = ["10.20.10.0/24"]
35         }
36         database = {
37             name           = "DatabaseSubnet"
38             address_prefixes = ["10.20.20.0/24"]
39         }
40     }
41 }
42
43 variable "tags" {
44     description = "Tags for resources"
45     type        = map(string)
46     default = {
47         environment = "lab"
48         task        = "task1"
49     }
50 }

```

Apply complete! Resources: 4 added, 0 changed, 0 destroyed.

### Outputs:

```
core_vnet_address_space = tolist([
  "10.20.0.0/16",
])
core_vnet_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54
etwork/virtualNetworks/CoreServicesVnet"
core_vnet_name = "CoreServicesVnet"
resource_group_id = "/subscriptions/16763438-d8c0-4e82-b6b9
resource_group_name = "az104-rg4"
subnet_ids = {
  "database" = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54
etwork/virtualNetworks/CoreServicesVnet/subnets/DatabaseSub
  "shared" = "/subscriptions/16763438-d8c0-4e82-b6b9-1c5473
work/virtualNetworks/CoreServicesVnet/subnets/SharedService
}
subnet_names = {
  "database" = "DatabaseSubnet"
  "shared" = "SharedServicesSubnet"
}
```

## Task 2: Створення ManufacturingVnet через шаблон providers.tf

```
1 terraform {
2   required_version = ">= 1.0"
3   required_providers {
4     azurerm = {
5       source = "hashicorp/azurerm"
6       version = "~>3.0"
7     }
8   }
9 }
10
11 provider "azurerm" {}
12   features {}
13 }
```

main.tf

```

1  data "azurerm_resource_group" "existing" {
2    name = var.resource_group_name
3  }
4
5  resource "azurerm_virtual_network" "manufacturing_vnet" {
6    name                = var.manufacturing_vnet_name
7    location            = data.azurerm_resource_group.existing.location
8    resource_group_name = data.azurerm_resource_group.existing.name
9    address_space       = var.manufacturing_vnet_address_space
10   tags                = var.tags
11 }
12
13 resource "azurerm_subnet" "manufacturing_subnets" {
14   for_each = var.manufacturing_subnets
15
16   name                = each.value.name
17   resource_group_name = data.azurerm_resource_group.existing.name
18   virtual_network_name = azurerm_virtual_network.manufacturing_vnet.name
19   address_prefixes    = each.value.address_prefixes
20 }

```

## outputs.tf

```

1  output "manufacturing_vnet_name" {
2    description = "Name of the Manufacturing VNet"
3    value       = azurerm_virtual_network.manufacturing_vnet.name
4  }
5
6  output "manufacturing_vnet_id" {
7    description = "ID of the Manufacturing VNet"
8    value       = azurerm_virtual_network.manufacturing_vnet.id
9  }
10
11 output "manufacturing_vnet_address_space" {
12   description = "Address space of Manufacturing VNet"
13   value       = azurerm_virtual_network.manufacturing_vnet.address_space
14 }
15
16 output "manufacturing_subnet_ids" {
17   description = "IDs of the Manufacturing subnets"
18   value       = { for k, v in azurerm_subnet.manufacturing_subnets : k => v.id }
19 }
20
21 output "manufacturing_subnet_names" {
22   description = "Names of the Manufacturing subnets"
23   value       = { for k, v in azurerm_subnet.manufacturing_subnets : k => v.name }
24 }

```

## variables.tf

```
1  variable "resource_group_name" {
2      description = "Name of the resource group"
3      type        = string
4      default     = "az104-rg4"
5  }
6
7  variable "location" {
8      description = "Azure region"
9      type        = string
10     default     = "East US"
11 }
12
13 variable "manufacturing_vnet_name" {
14     description = "Name of the Manufacturing VNet"
15     type        = string
16     default     = "ManufacturingVnet"
17 }
18
19 variable "manufacturing_vnet_address_space" {
20     description = "Address space for Manufacturing VNet"
21     type        = list(string)
22     default     = ["10.30.0.0/16"]
23 }
24
25 variable "manufacturing_subnets" {
26     description = "Subnets for Manufacturing VNet"
27     type = map(object({
28         name           = string
29         address_prefixes = list(string)
30     }))
31     default = {
32         sensor1 = {
33             name           = "SensorSubnet1"
34             address_prefixes = ["10.30.20.0/24"]
35         }
36         sensor2 = {
37             name           = "SensorSubnet2"
38             address_prefixes = ["10.30.21.0/24"]
39         }
40     }
41 }
42
43 variable "tags" {}
44     description = "Tags for resources"
45     type        = map(string)
46     default = {
47         environment = "lab"
48         task        = "task2"
49     }
50
```

Apply complete! Resources: 3 added, 0 changed, 0 destroyed.

### Outputs:

```
manufacturing_subnet_ids = {
  "sensor1" = "/subscriptions/16763438-d8c0-4e82-b6b9-1c547
work/virtualNetworks/ManufacturingVnet/subnets/SensorSubne
  "sensor2" = "/subscriptions/16763438-d8c0-4e82-b6b9-1c547
work/virtualNetworks/ManufacturingVnet/subnets/SensorSubne
}
manufacturing_subnet_names = {
  "sensor1" = "SensorSubnet1"
  "sensor2" = "SensorSubnet2"
}
manufacturing_vnet_address_space = tolist([
  "10.30.0.0/16",
])
manufacturing_vnet_id = "/subscriptions/16763438-d8c0-4e82-
crosoft.Network/virtualNetworks/ManufacturingVnet"
manufacturing_vnet_name = "ManufacturingVnet"
```

### Task 3: Налаштування ASG та NSG

#### providers.tf

```
1 terraform {
2   required_version = ">= 1.0"
3   required_providers {
4     azurerm = {
5       source = "hashicorp/azurerm"
6       version = "~>3.0"
7     }
8   }
9 }
10
11 provider "azurerm" {}
12 features {}
13 }
```

#### main.tf



```

1  data "azurerm_resource_group" "existing" {
2    name = var.resource_group_name
3  }
4
5  data "azurerm_virtual_network" "core_vnet" {
6    name                = var.core_vnet_name
7    resource_group_name = var.resource_group_name
8  }
9
10 data "azurerm_subnet" "shared_subnet" {
11   name                = var.shared_subnet_name
12   virtual_network_name = var.core_vnet_name
13   resource_group_name = var.resource_group_name
14 }
15
16 # Application Security Group
17 resource "azurerm_application_security_group" "asg_web" {
18   name                = var.asg_name
19   location            = data.azurerm_resource_group.existing.location
20   resource_group_name = data.azurerm_resource_group.existing.name
21   tags               = var.tags
22 }
23
24 # Network Security Group
25 resource "azurerm_network_security_group" "nsg_secure" {
26   name                = var.nsg_name
27   location            = data.azurerm_resource_group.existing.location
28   resource_group_name = data.azurerm_resource_group.existing.name
29   tags               = var.tags
30 }
31
32 # Inbound Rule - Allow ASG Traffic
33 resource "azurerm_network_security_rule" "allow_asg" {
34   name                = "AllowASG"
35   priority            = 100
36   direction           = "Inbound"
37   access              = "Allow"
38   protocol            = "Tcp"
39   source_port_range   = "*"
40   destination_port_ranges = ["80", "443"]
41   source_application_security_group_ids = [azurerm_application_security_group.asg_web.id]
42   destination_address_prefix = "*"
43   resource_group_name = data.azurerm_resource_group.existing.name
44   network_security_group_name = azurerm_network_security_group.nsg_secure.name
45 }
46
47 # Outbound Rule - Deny Internet
48 resource "azurerm_network_security_rule" "deny_internet_outbound" {}
49   name                = "DenyInternetOutbound"
50   priority            = 4096
51   direction           = "Outbound"
52   access              = "Deny"
53   protocol            = "*"
54   source_port_range   = "*"
55   destination_port_range = "*"
56   source_address_prefix = "*"
57   destination_address_prefix = "Internet"
58   resource_group_name = data.azurerm_resource_group.existing.name
59   network_security_group_name = azurerm_network_security_group.nsg_secure.name
60 }
61
62 # Associate NSG with Subnet
63 resource "azurerm_subnet_network_security_group_association" "nsg_subnet_association" {
64   subnet_id          = data.azurerm_subnet.shared_subnet.id
65   network_security_group_id = azurerm_network_security_group.nsg_secure.id
66 }

```

outputs.tf

```

1  output "asg_id" {
2    description = "ID of the Application Security Group"
3    value       = azurerm_application_security_group.asg_web.id
4  }
5
6  output "asg_name" {
7    description = "Name of the Application Security Group"
8    value       = azurerm_application_security_group.asg_web.name
9  }
10
11 output "nsg_id" {
12   description = "ID of the Network Security Group"
13   value       = azurerm_network_security_group.nsg_secure.id
14 }
15
16 output "nsg_name" {
17   description = "Name of the Network Security Group"
18   value       = azurerm_network_security_group.nsg_secure.name
19 }
20
21 output "inbound_rule_id" {
22   description = "ID of the Allow ASG inbound rule"
23   value       = azurerm_network_security_rule.allow_asg.id
24 }
25
26 output "outbound_rule_id" {
27   description = "ID of the Deny Internet outbound rule"
28   value       = azurerm_network_security_rule.deny_internet_outbound.id
29 }
30
31 output "subnet_nsg_association_id" {
32   description = "ID of the subnet-NSG association"
33   value       = azurerm_subnet_network_security_group_association.nsg_subnet_association.id
34 }

```

## variables.tf

```
1  variable "resource_group_name" {
2      description = "Name of the resource group"
3      type        = string
4      default     = "az104-rg4"
5  }
6
7  variable "location" {
8      description = "Azure region"
9      type        = string
10     default     = "East US"
11 }
12
13 variable "asg_name" {
14     description = "Name of the Application Security Group"
15     type        = string
16     default     = "asg-web"
17 }
18
19 variable "nsg_name" {
20     description = "Name of the Network Security Group"
21     type        = string
22     default     = "myNSGSecure"
23 }
24
25 variable "core_vnet_name" {
26     description = "Name of the Core Services VNet"
27     type        = string
28     default     = "CoreServicesVnet"
29 }
30
31 variable "shared_subnet_name" {
32     description = "Name of the SharedServices Subnet"
33     type        = string
34     default     = "SharedServicesSubnet"
35 }
36
37 variable "tags" {
38     description = "Tags for resources"
39     type        = map(string)
40     default = {
41         environment = "lab"
42         task        = "task3"
43     }
44 }
```

Apply complete! Resources: 5 added, 0 changed, 0 destroyed.

#### Outputs:

```
asg_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1f/applicationSecurityGroups/asg-web"
asg_name = "asg-web"
inbound_rule_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1f/Network/networkSecurityGroups/myNSGSecure/securityRules/AllowHttp"
nsg_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1f/networkSecurityGroups/myNSGSecure"
nsg_name = "myNSGSecure"
outbound_rule_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1f/Network/networkSecurityGroups/myNSGSecure/securityRules/AllowHttps"
subnet_nsg_association_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1f/Microsoft.Network/virtualNetworks/CoreServicesVnet/subnets/subnet1"
subnet_name = "subnet1"
```

#### Task 4: Налаштування публічних та приватних DNS зон providers.tf

```
1  ∨ terraform {
2    required_version = ">= 1.0"
3  ∨  required_providers {
4    ∨    azurerm = {
5      source = "hashicorp/azurerm"
6      version = "~>3.0"
7    }
8  }
9  }
10
11 ∨ provider "azurerm" {}
12   features {}
13 }
```

main.tf

```

1  data "azurerm_resource_group" "existing" {
2  |   name = var.resource_group_name
3  | }
4
5  data "azurerm_virtual_network" "manufacturing_vnet" {
6  |   name                = var.manufacturing_vnet_name
7  |   resource_group_name = var.resource_group_name
8  | }
9
10 # Public DNS Zone
11 resource "azurerm_dns_zone" "public" {
12 |   name                = var.public_dns_zone_name
13 |   resource_group_name = data.azurerm_resource_group.existing.name
14 |   tags                = var.tags
15 | }
16
17 # Public DNS A Record for www
18 resource "azurerm_dns_a_record" "www" {
19 |   name                = "www"
20 |   zone_name           = azurerm_dns_zone.public.name
21 |   resource_group_name = data.azurerm_resource_group.existing.name
22 |   ttl                 = 1
23 |   records              = [var.www_record_ip]
24 | }
25
26 # Private DNS Zone
27 resource "azurerm_private_dns_zone" "private" {
28 |   name                = var.private_dns_zone_name
29 |   resource_group_name = data.azurerm_resource_group.existing.name
30 |   tags                = var.tags
31 | }
32
33 # Virtual Network Link for Private DNS
34 resource "azurerm_private_dns_zone_virtual_network_link" "manufacturing_link" {
35 |   name                = "manufacturing-link"
36 |   resource_group_name = data.azurerm_resource_group.existing.name
37 |   private_dns_zone_name = azurerm_private_dns_zone.private.name
38 |   virtual_network_id   = data.azurerm_virtual_network.manufacturing_vnet.id
39 |   registration_enabled = false
40 |   tags                = var.tags
41 | }
42
43 # Private DNS A Record for sensorvm
44 resource "azurerm_private_dns_a_record" "sensorvm" {
45 |   name                = "sensorvm"
46 |   zone_name           = azurerm_private_dns_zone.private.name
47 |   resource_group_name = data.azurerm_resource_group.existing.name
48 |   ttl                 = 1
49 |   records              = [var.sensor_vm_ip]
50 | }

```

outputs.tf

```

1  output "public_dns_zone_id" {
2    | description = "ID of the public DNS zone"
3    | value      = azurerm_dns_zone.public.id
4  }
5
6  output "public_dns_zone_name" {
7    | description = "Name of the public DNS zone"
8    | value      = azurerm_dns_zone.public.name
9  }
10
11 output "public_dns_name_servers" {
12 | description = "Name servers for the public DNS zone"
13 | value      = azurerm_dns_zone.public.name_servers
14 }
15
16 output "www_record_fqdn" {
17 | description = "FQDN of the www A record"
18 | value      = azurerm_dns_a_record.www.fqdn
19 }
20
21 output "private_dns_zone_id" {
22 | description = "ID of the private DNS zone"
23 | value      = azurerm_private_dns_zone.private.id
24 }
25
26 output "private_dns_zone_name" {
27 | description = "Name of the private DNS zone"
28 | value      = azurerm_private_dns_zone.private.name
29 }
30
31 output "vnet_link_id" {
32 | description = "ID of the virtual network link"
33 | value      = azurerm_private_dns_zone_virtual_network_link.manufacturing_link.id
34 }
35
36 output "sensorvm_record_fqdn" {
37 | description = "FQDN of the sensorvm A record"
38 | value      = azurerm_private_dns_a_record.sensorvm.fqdn
39 }

```

**variables.tf**

```
1  variable "resource_group_name" {
2      description = "Name of the resource group"
3      type        = string
4      default     = "az104-rg4"
5  }
6
7  variable "location" {
8      description = "Azure region"
9      type        = string
10     default     = "East US"
11 }
12
13 variable "public_dns_zone_name" {
14     description = "Name of the public DNS zone"
15     type        = string
16     default     = "contoso-lab04-12345.com"
17 }
18
19 variable "private_dns_zone_name" {
20     description = "Name of the private DNS zone"
21     type        = string
22     default     = "private.contoso.com"
23 }
24
25 variable "manufacturing_vnet_name" {
26     description = "Name of the Manufacturing VNet"
27     type        = string
28     default     = "ManufacturingVnet"
29 }
30
31 variable "www_record_ip" {
32     description = "IP address for www A record"
33     type        = string
34     default     = "10.1.1.4"
35 }
36
37 variable "sensor_vm_ip" {
38     description = "IP address for sensorvm A record"
39     type        = string
40     default     = "10.1.1.4"
41 }
42
43 variable "tags" {
44     description = "Tags for resources"
45     type        = map(string)
46     default = {
47         environment = "lab"
48         task        = "task4"
49     }
50 }
```

Apply complete! Resources: 2 added, 0 changed, 0 destroyed.

### Outputs:

```
private_dns_zone_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c547e2f0a0e/ResourceGroups/lab04/providers/Microsoft.Network/privateDnsZones/private.contoso.com"
private_dns_zone_name = "private.contoso.com"
public_dns_name_servers = toset([
  "ns1-05.azure-dns.com.",
  "ns2-05.azure-dns.net.",
  "ns3-05.azure-dns.org.",
  "ns4-05.azure-dns.info.",
])
public_dns_zone_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c547e2f0a0e/ResourceGroups/lab04/providers/Microsoft.Network/dnsZones/contoso-lab04-12345.com"
public_dns_zone_name = "contoso-lab04-12345.com"
sensorvm_record_fqdn = "sensorvm.private.contoso.com."
vnet_link_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c547e2f0a0e/ResourceGroups/lab04/providers/Microsoft.Network/privateDnsZones/private.contoso.com/virtualNetworkLinks/sensorvm-link"
www_record_fqdn = "www.contoso-lab04-12345.com."
```

## Висновок

Робота дозволила практично реалізувати багаторівневу мережеву архітектуру, яка є фундаментом для будь-якої хмарної системи.

- Проектування VNets: Створено центральну мережу CoreServicesVnet з виокремленими підмережами для спільних сервісів та баз даних, а також мережу ManufacturingVnet для специфічних індустріальних задач.
- Контроль доступу (NSG & ASG): Впроваджено механізми безпеки за допомогою Network Security Groups та Application Security Groups. Це дозволило налаштувати тонкі правила фільтрації трафіку (наприклад, дозволити лише HTTP/HTTPS доступ до веб-рівня та заблокувати вихідний трафік в інтернет).
- Керування іменами (DNS): Реалізовано інтеграцію публічних DNS-зон для зовнішнього доступу та приватних DNS-зон для внутрішньої комунікації між ресурсами у ManufacturingVnet без використання публічних IP-адрес.

Гітхаб: [https://github.com/Illoizaur/azure\\_labs/tree/main/lab4](https://github.com/Illoizaur/azure_labs/tree/main/lab4)