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**Хмарні технології**

**Практична робота №4**

**Тема:** Implement Virtual Networking

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

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## 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 | provider "azurerm" {  
11     features {}  
12 }  
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.azure_rm_resource_group.existing.location
8    resource_group_name = data.azure_rm_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.azure_rm_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
twork/virtualNetworks/ManufacturingVnet/subnets/SensorSubne
    "sensor2" = "/subscriptions/16763438-d8c0-4e82-b6b9-1c547
twork/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-b6b9-1c54738e6d1
/applicationSecurityGroups/asg-web"
asg_name = "asg-web"
inbound_rule_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1
/t.Network/networkSecurityGroups/myNSGSecure/securityRules/A
nsg_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1
/networkSecurityGroups/myNSGSecure"
nsg_name = "myNSGSecure"
outbound_rule_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1
/t.Network/networkSecurityGroups/myNSGSecure/securityRules/B
subnet_nsg_association_id = "/subscriptions/16763438-d8c0-4e82-b6b9-1c54738e6d1
s/Microsoft.Network/virtualNetworks/CoreServicesVnet/subnets
```

**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.azure_rm_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.azure_rm_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.azure_rm_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.azure_rm_resource_group.existing.name
37   private_dns_zone_name = azurerm_private_dns_zone.private.name
38   virtual_network_id    = data.azure_rm_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.azure_rm_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_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_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-b6osoft.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-b6bsoft.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-b6b9-1c54etwork/privateDnsZones/private.contoso.com/virtualNetworkL
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/Iolloizaur/azure\\_labs/tree/main/lab4](https://github.com/Iolloizaur/azure_labs/tree/main/lab4)