**--- Deep Model (Test) ---**

precision recall f1-score support

Benign 0.9947 0.8756 0.9314 296598

Bot 0.0231 0.9953 0.0452 215

DDoS 0.7385 0.9985 0.8490 19202

DoS GoldenEye 0.7668 0.9546 0.8505 1543

DoS Hulk 0.9452 0.9459 0.9456 25927

DoS Slowhttptest 0.6305 0.9923 0.7711 784

DoS slowloris 0.6115 0.9876 0.7553 808

FTP-Patator 0.6871 0.9944 0.8127 890

Heartbleed 0.0078 1.0000 0.0155 1

Infiltration 0.0025 0.6000 0.0051 5

PortScan 0.1404 0.9558 0.2449 294

SSH-Patator 0.5976 0.9130 0.7224 483

Web Attack � Brute Force 0.0921 0.9186 0.1674 221

Web Attack � Sql Injection 0.0002 1.0000 0.0005 3

Web Attack � XSS 0.0154 0.0612 0.0246 98

accuracy 0.8889 347072

macro avg 0.4169 0.8795 0.4761 347072

weighted avg 0.9705 0.8889 0.9242 347072

Confusion matrix shape: (15, 15)

Applying FSM rules on validation and test sets (raw features)... this may take a moment

**170/170** ━━━━━━━━━━━━━━━━━━━━ **59s** 344ms/step

**Validation: DL only**

precision recall f1-score support

Benign 0.9944 0.8758 0.9313 296597

Bot 0.0233 0.9954 0.0455 216

DDoS 0.7408 0.9976 0.8502 19202

DoS GoldenEye 0.7728 0.9566 0.8549 1543

DoS Hulk 0.9431 0.9442 0.9436 25927

DoS Slowhttptest 0.6275 0.9885 0.7677 784

DoS slowloris 0.6023 0.9839 0.7472 808

FTP-Patator 0.6885 0.9944 0.8136 889

Heartbleed 0.0143 1.0000 0.0282 2

Infiltration 0.0033 0.6667 0.0065 6

PortScan 0.1351 0.9454 0.2364 293

SSH-Patator 0.6335 0.9234 0.7515 483

Web Attack � Brute Force 0.0928 0.9182 0.1685 220

Web Attack � Sql Injection 0.0002 1.0000 0.0005 3

Web Attack � XSS 0.0087 0.0306 0.0136 98

accuracy 0.8888 347071

macro avg 0.4187 0.8814 0.4773 347071

weighted avg 0.9703 0.8888 0.9242 347071

**Validation: Hybrid (DL+FSM)**

precision recall f1-score support

Benign 0.9994 0.8446 0.9155 296597

Bot 0.0209 0.9954 0.0410 216

DDoS 0.4281 0.9985 0.5992 19202

DoS GoldenEye 0.7751 0.9559 0.8561 1543

DoS Hulk 0.9509 0.9424 0.9466 25927

DoS Slowhttptest 0.6546 0.9885 0.7876 784

DoS slowloris 0.6239 0.9629 0.7572 808

FTP-Patator 0.7429 0.9944 0.8504 889

Heartbleed 0.0157 1.0000 0.0310 2

Infiltration 0.0040 0.6667 0.0079 6

PortScan 0.1357 0.9454 0.2374 293

SSH-Patator 0.6344 0.9234 0.7521 483

Web Attack � Brute Force 0.0940 0.9136 0.1704 220

Web Attack � Sql Injection 0.0003 0.3333 0.0005 3

Web Attack � XSS 0.0087 0.0306 0.0136 98

accuracy 0.8620 347071

macro avg 0.4059 0.8330 0.4644 347071

weighted avg 0.9581 0.8620 0.8971 347071

WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save\_model(model)`. This file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my\_model.keras')` or `keras.saving.save\_model(model, 'my\_model.keras')`.

**Test: DL only**

precision recall f1-score support

Benign 0.9947 0.8756 0.9314 296598

Bot 0.0231 0.9953 0.0452 215

DDoS 0.7385 0.9985 0.8490 19202

DoS GoldenEye 0.7668 0.9546 0.8505 1543

DoS Hulk 0.9452 0.9459 0.9456 25927

DoS Slowhttptest 0.6305 0.9923 0.7711 784

DoS slowloris 0.6115 0.9876 0.7553 808

FTP-Patator 0.6871 0.9944 0.8127 890

Heartbleed 0.0078 1.0000 0.0155 1

Infiltration 0.0025 0.6000 0.0051 5

PortScan 0.1404 0.9558 0.2449 294

SSH-Patator 0.5976 0.9130 0.7224 483

Web Attack � Brute Force 0.0921 0.9186 0.1674 221

Web Attack � Sql Injection 0.0002 1.0000 0.0005 3

Web Attack � XSS 0.0154 0.0612 0.0246 98

accuracy 0.8889 347072

macro avg 0.4169 0.8795 0.4761 347072

weighted avg 0.9705 0.8889 0.9242 347072

**Test: Hybrid (DL+FSM)**

precision recall f1-score support

Benign 0.9995 0.8442 0.9153 296598

Bot 0.0208 0.9953 0.0408 215

DDoS 0.4281 0.9990 0.5993 19202

DoS GoldenEye 0.7676 0.9546 0.8510 1543

DoS Hulk 0.9534 0.9447 0.9490 25927

DoS Slowhttptest 0.6727 0.9911 0.8014 784

DoS slowloris 0.6272 0.9703 0.7619 808

FTP-Patator 0.7342 0.9933 0.8443 890

Heartbleed 0.0081 1.0000 0.0161 1

Infiltration 0.0031 0.6000 0.0061 5

PortScan 0.1412 0.9558 0.2461 294

SSH-Patator 0.6000 0.9130 0.7241 483

Web Attack � Brute Force 0.0940 0.9186 0.1706 221

Web Attack � Sql Injection 0.0005 0.6667 0.0010 3

Web Attack � XSS 0.0154 0.0612 0.0246 98

accuracy 0.8619 347072

macro avg 0.4044 0.8539 0.4635 347072

weighted avg 0.9584 0.8619 0.8972 347072