SAP's Network Protocols Revisited

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March 2014

AGENDA

SAP SECURITY

NETWORK PENETRATION TESTING

THIS TALK

APPROACH

TOOLS

CLASSIC SAP ENV

- SAP ROUTER
- SAP GATEWAY/RFC
- SAP DISPATCHER/DIAG
- SAP MESSAGE SERVER
- SAP ENQUEUE SERVER

MODERN SAP ENV

- SAP NW GATEWAY
- SAP HANA

DISCOVERY & INFO GATHERING

VULN ASSESSMENT & EXPLOITATION

DEFENSE

CONCLUSIONS

SAP SECURITY

+ INFO

+ TOOLS

+ STANDARS

+ RESEARCH

+ COMPANIES

+ MEDIA ATTENTION

SAP SECURITY

- NON-SPECIALISTS
- MOST ON APP LAYER
- STEEP LEARNING CURVE
- NON-TARGETED PENTEST
- MEDIA ATTENTION

NETWORK PENETRATION TESTING

DISCOVERY

INFO GATHERING

VULN ASSESSMENT

EXPLOITAITION

POST-EXPLOITATION

NETWORK PENETRATION TESTING

ON A SAP ENV?

THIS TALK

OLD & NEW

EXCLUDED WEB

NOT ALL COVERED

NOT A PENTEST GUIDE

APPROACH

BLACK-BOX

WORK IN PROGRESS

INCREMENTAL LEARNING

RELY ON OTHER’S WORK

NOT COMPLETE ACCURATE

TOOLS

pysap

PYTHON LIBRARY

CRAFT PACKETS

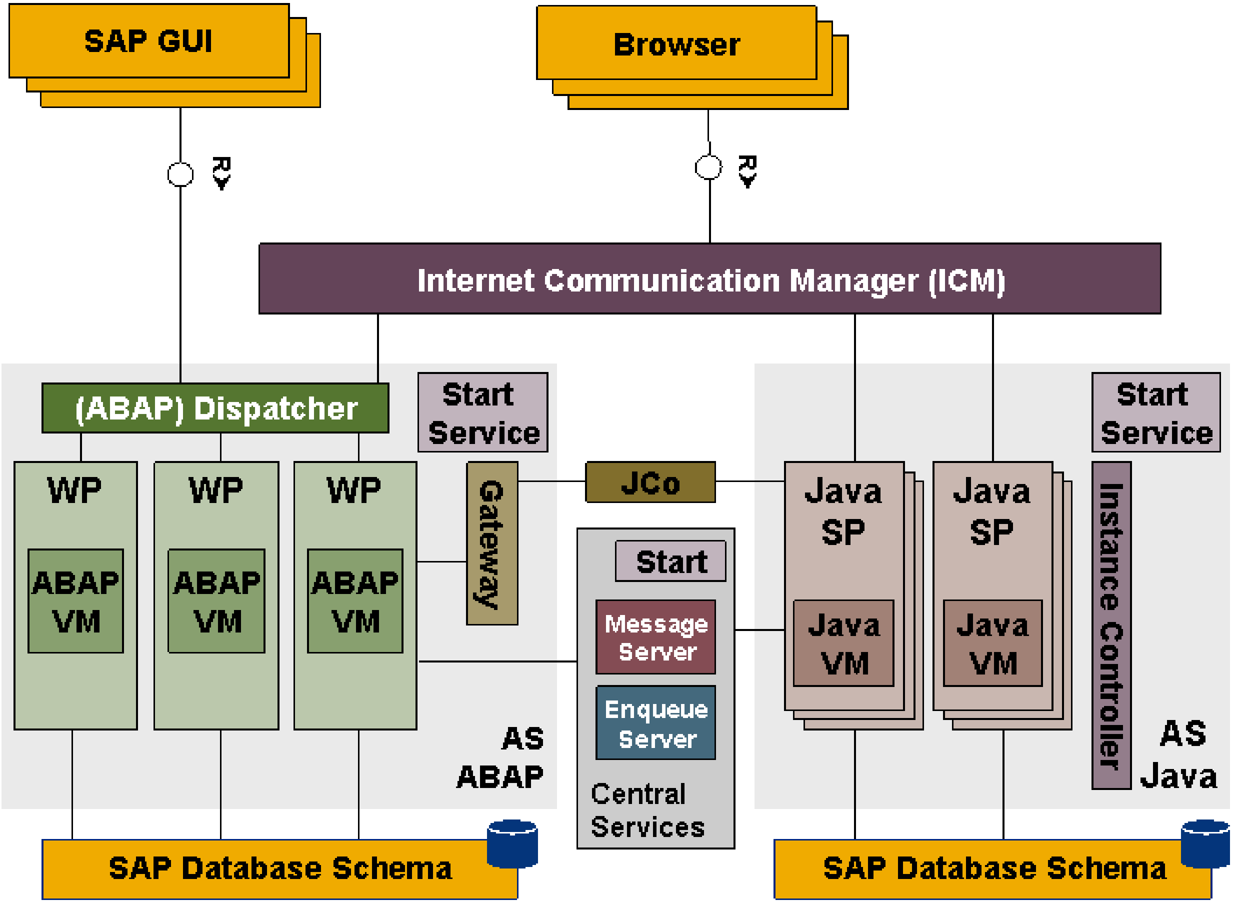
WIRESHARK PLUGIN

DISSECT SAP PROTOCOLS

pysap

Wireshark plugin

CLASSIC SAP ENV



CLASSIC SAP ENV

SAP ROUTER

SAP GATEWAY/RFC

SAP DISPATCHER/DIAG

SAP MESSAGE SERVER

SAP ENQUEUE SERVER

SAP ROUTER

APPLICATION LEVEL-GATEWAY

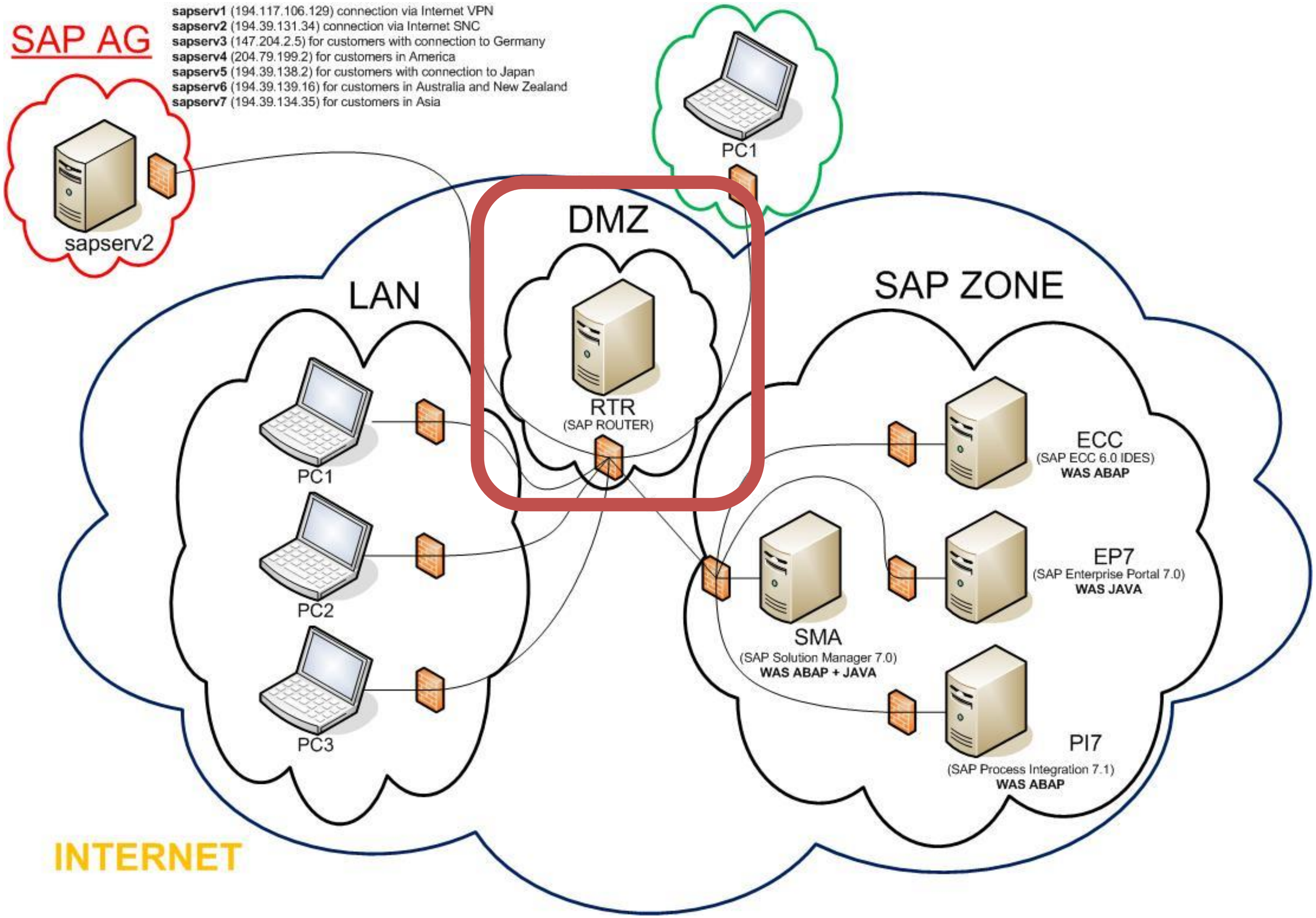
REVERSE PROXY

STAND ALONE APP

ON ALL SAPs INSTALLATIONS

UNENCRYPTED BY DEFAULT

INTERNET EXPOSED



sapserv1 (194.117.106.129) connection via Internet VPN
sapserv2 (194.39.131.34) connection via Internet SNC
sapserv3 (147.204.2.5) for customers with connection to Germany
sapserv4 (204.79.199.2) for customers in America
sapserv5 (194.39.138.2) for customers with connection to Japan
sapserv6 (194.39.139.16) for customers in Australia and New Zealand
sapserv7 (194.39.134.35) for customers in Asia

SAP ROUTER

WELL-KNOWN ATTACKS:

INFO REQUEST

USE AS A PROXY

SNIFF ROUTE/PASSWORDS

SCAN INTERNAL NETWORKS

Mariano's talk at HITB 2010

Dave's SAP Smashing blog post

SAP ROUTER

LOOKING INSIDE:

ADMIN PACKETS

CONTROL MESSAGES

ERROR INFORMATION

ROUTE REQUEST

PONG

SAP ROUTER

ADMIN PACKETS:

REMOTE ADMINISTRATION
FOUND UNDOCUMENTED
COMMANDS: SET/CLEAR PEER TRACE,
TRACE CONNECTION

SAP ROUTER

CONTROL MESSAGES:

INTERNAL CONTROL UNDOCUMENTED OPCODES: VERSION REQUEST/REPONSE, SET HANDLE, SNC REQUEST/ACK

SAP ROUTER

ROUTE REQUEST:

ROUTE STRING

LIST OF ROUTING HOPS

PASSWORD PROTECTED (OPTIONAL)

SAP ROUTER

RECENT ATTACKS:

INFO DISCLOSURE

ROUTE STRING HEAP OVERFLOW

ERPScan's DSECRG-13-013 advisory

SAP Security Notes 1820666 / 1663732

SAP ROUTER

SECURITY MEASURES:

PATCH

ENFORCE SNC USE

HARDEN ROUTE TABLE

PUT BEHIND FIREWALL

DON'T USE PASSWORDS

SAP GATEWAY/RFC

RFC INTERFACE

INTEGRATION W/EXT SERVERS

UNENCRYPTED BY DEFAULT

GENERALLY EXPOSED

SAP GATEWAY/RFC

WELL-KNOWN ATTACKS:

INFO GATHERING

MONITOR MODE

MITM / SNIFFING

SOME RCE VULNS

Mariano's Attacking the Giants talk at BlackHat and Deepsec 2007
and SAP Penetration Testing talk at BlackHat 2009

SAP GATEWAY/RFC

WELL-KNOWN ATTACKS:

LOGIN BRUTE-FORCE

+ TONS OF ATTACKS ON RFCs

RFC EXEC, SAPXPG,

CALLBACK, EVIL TWIN, …

Mariano’s Attacking the Giants talk at BlackHat and Deepsec 2007
and SAP Penetration Testing talk at BlackHat 2009

SAP GATEWAY/RFC

LOOKING INSIDE:

MAIN PACKETS

MONITOR PACKETS

RFC TABLES

SAP GATEWAY/RFC

SECURITY MEASURES:

PATCH (CLIENT/SERVER)

USE ACLs

DISABLE MONITOR

ENFORCE SNC USE

ENABLE (AND REVIEW) LOGS

Security Settings in the SAP Gateway

SAP DISPATCHER/DIAG

COMM BETWEEN GUI/APP SERVER

RFC EMBEDDED CALLS

ONLY COMPRESSED

UNENCRYPTED BY DEFAULT

SAP DISPATCHER/DIAG

WELL-KNOWN ATTACKS:

ATTACKS ON GUI CLIENTS

SNIFFING LOGIN CREDENTIALS

Secaron's sniffing paper
Ian's Talk at 44con 2011
Andrea's Talk at Troopers 2011

SAP DISPATCHER/DIAG

RECENT ATTACKS:

INFO GATHERING

LOGIN BRUTE-FORCE

ROGUE SERVER + GUI SHORTCUT

BUFFER OVERFLOWS (W/TRACE ON)

Talk at Defcon 20/Brucon 2012

CORE-2012-0123 Advisory

SAP DISPATCHER/DIAG

SECURITY MEASURES:

PATCH (SERVER / GUI)

ENFORCE SNC USE

SAP MESSAGE SERVER

ONE PER SYSTEM

LOAD BALANCING FOR GUI/RFC

INTERNAL COMM W/APP SERVERS

INT/EXT TCP PORT + HTTP

SAP MESSAGE SERVER

WELL-KNOWN ATTACKS:

MONITOR MODE

INFO GATHERING (HOW?)

IMPERSONATE APP SERVER (HOW?)

OLD BUFFER OVERFLOWS ON HTTP

SAP MESSAGE SERVER

LOOKING INSIDE:

MAIN PACKETS

ADM PACKETS

~ 60 ADMIN OPCODES

~ 75 REGULAR OPCODES

SAP MESSAGE SERVER

LOOKING INSIDE:

DUMP DATA

MONITOR CLIENTS

SEND/RECV MESSAGES

CHANGE CONFIG PARAM

SAP MESSAGE SERVER

RECENT ATTACKS:

MS BUFFER OVERFLOWS

ZDI-12-104/111/112 Advisories
SAP Security Notes 1649838 / 1649840

SAP MESSAGE SERVER

Francisco Falcon
@fdfalcon

RECENT ATTACKS:

SATISFACTION 100% GUARANTEED

MS MEMORY CORRUPTION

GIVE CONN ADMIN PRIVS

OVERWRITE CHANGE PARAM FUNCTION POINTER

SEND CHANGE PARAM WITH PAYLOAD

PWN

CORE-2012-1128 Advisory

SAP Security Note 1800603

SAP MESSAGE SERVER

NEW/OLD ATTACKS:

IMPERSONATE APP SERVER

SAP MESSAGE SERVER

ACCESS LEVEL:

	EXTERNAL PORT	INTERNAL PORT	MONITOR MODE
MONITOR CLIENTS	X		
MS BUFFER OVERFLOW	X	X	
MS MEMORY CORRUPTION	X	X	
DUMP DATA		X	
IMPERSONATE APP SERVER		X	
CHANGE PARAM		X	X

SAP MESSAGE SERVER

SECURITY MEASURES:

PATCH

USE ACLs

DISABLE MONITOR

SEPARATE INT/EXT PORT

ENABLE (AND REVIEW) LOGS

Security Settings for the SAP Message Server

SAP Security Note 821875

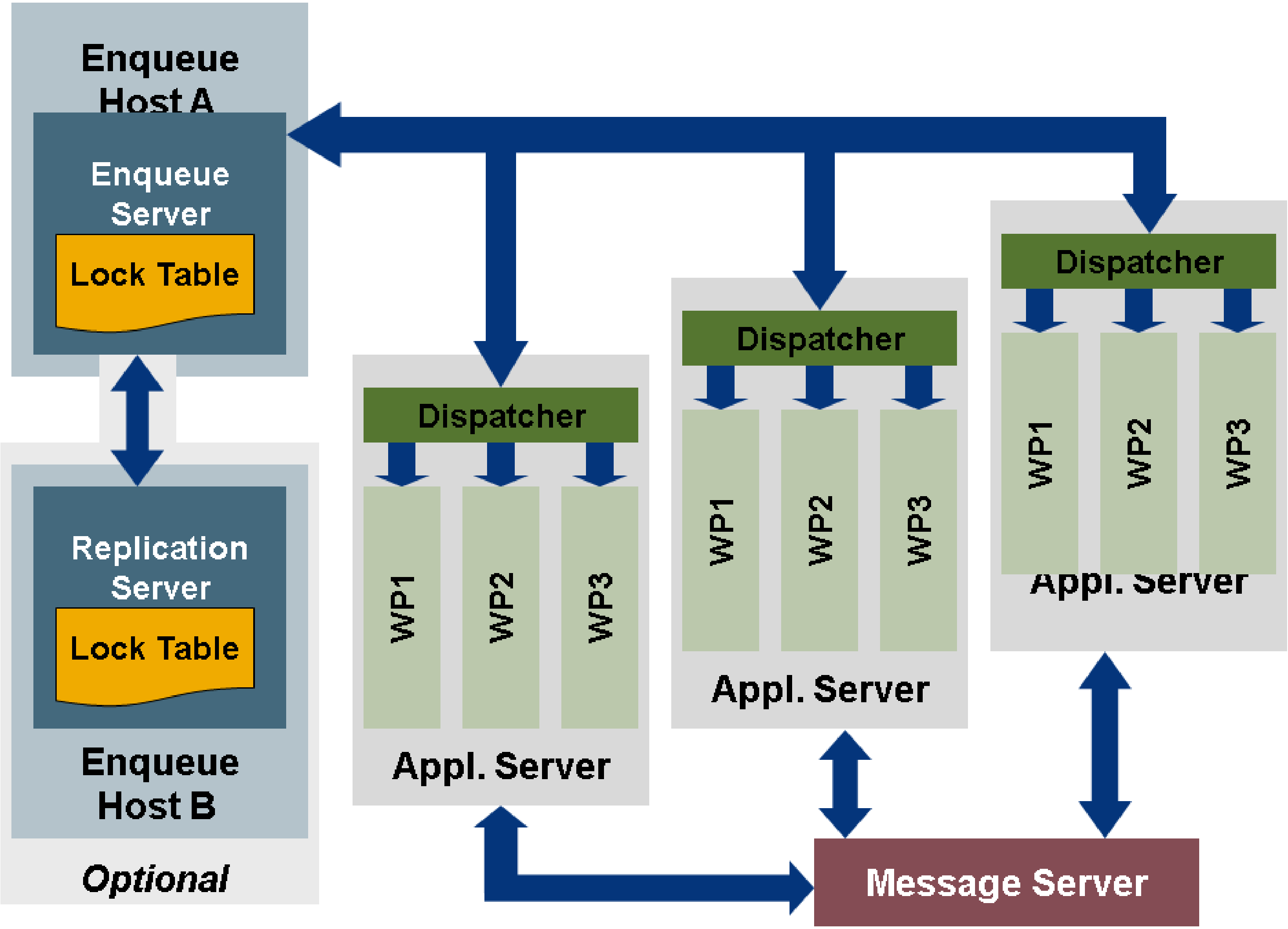
SAP ENQUEUE SERVER

ONE PER SYSTEM

LOCK MECHANISM

CAN RUN STANDALONE

REPLICATION SERVER FOR HA


Enqueue Host A
Enqueue Server
Lock Table
Replication Server
Lock Table
Enqueue Host B
Optional
Dispatcher
WP1
WP2
WP3
Appl. Server
Dispatcher
WP1
WP2
WP3
Appl. Server
Dispatcher
WP1
WP2
WP3
Appl. Server
Message Server

SAP ENQUEUE SERVER

WELL-KNOWN ATTACKS:

???

SERVER CRASHES (???)

TRANSFER FILES (???)

SAP Security Notes 948457 / 959877

SAP ENQUEUE SERVER

LOOKING INSIDE:

CONNECTION ADMIN

SERVER ADMIN

REPLICATION

STATS

SAP ENQUEUE SERVER

SECURITY MEASURES:

PATCH

USE ACLs

ENABLE (AND REVIEW) LOGS

RESTRICT ACCESS TO THE SERVICE

(NO SNC SUPPORTED?)

SAP Security Notes 1879601 /1495075

CLASSIC SAP ENV

~~SAP ROUTER~~

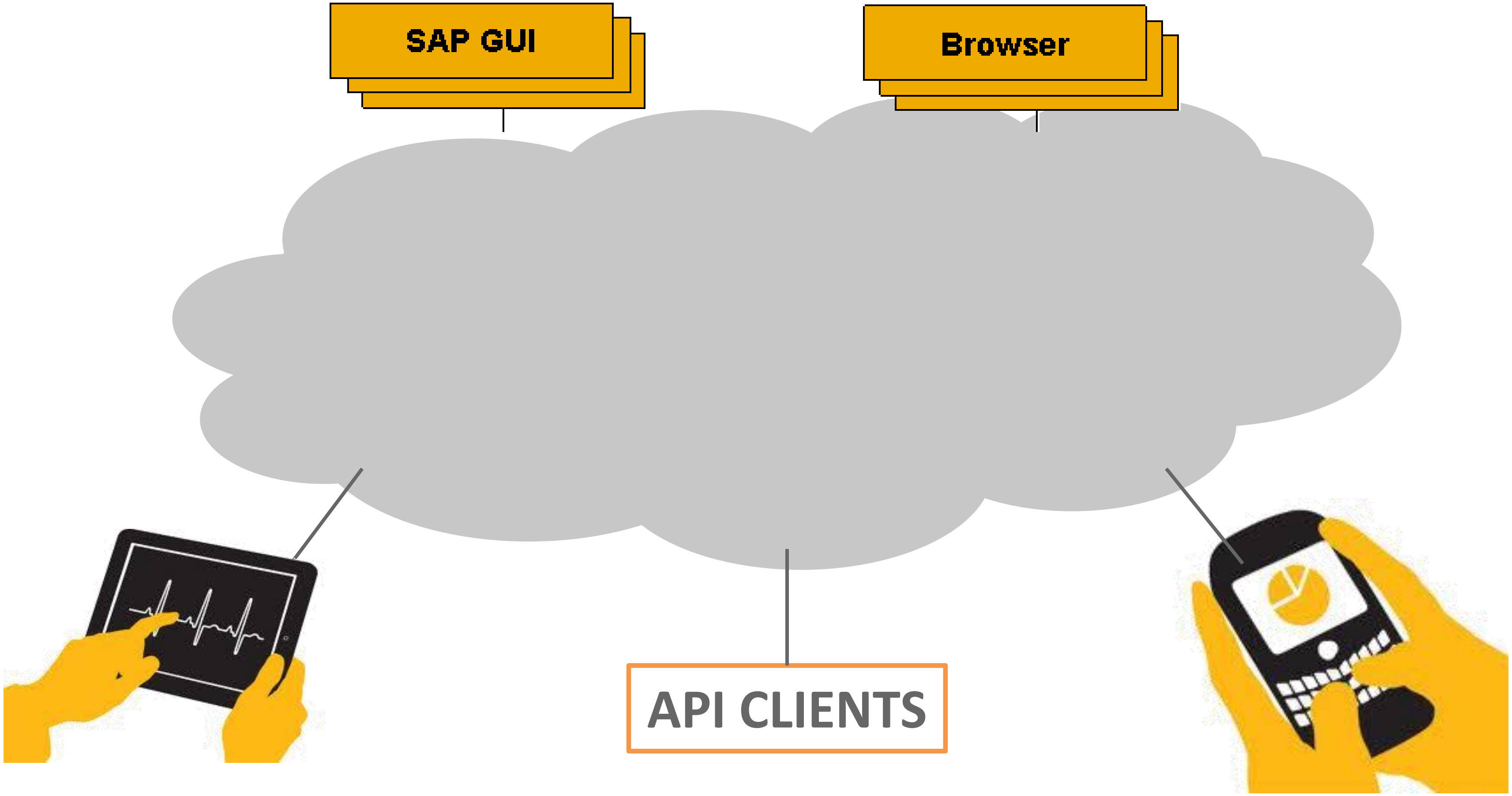
~~SAP GATEWAY/RFC~~

~~SAP DISPATCHER/DIAG~~

~~SAP MESSAGE SERVER~~

~~SAP ENQUEUE SERVER~~

MODERN SAP ENV

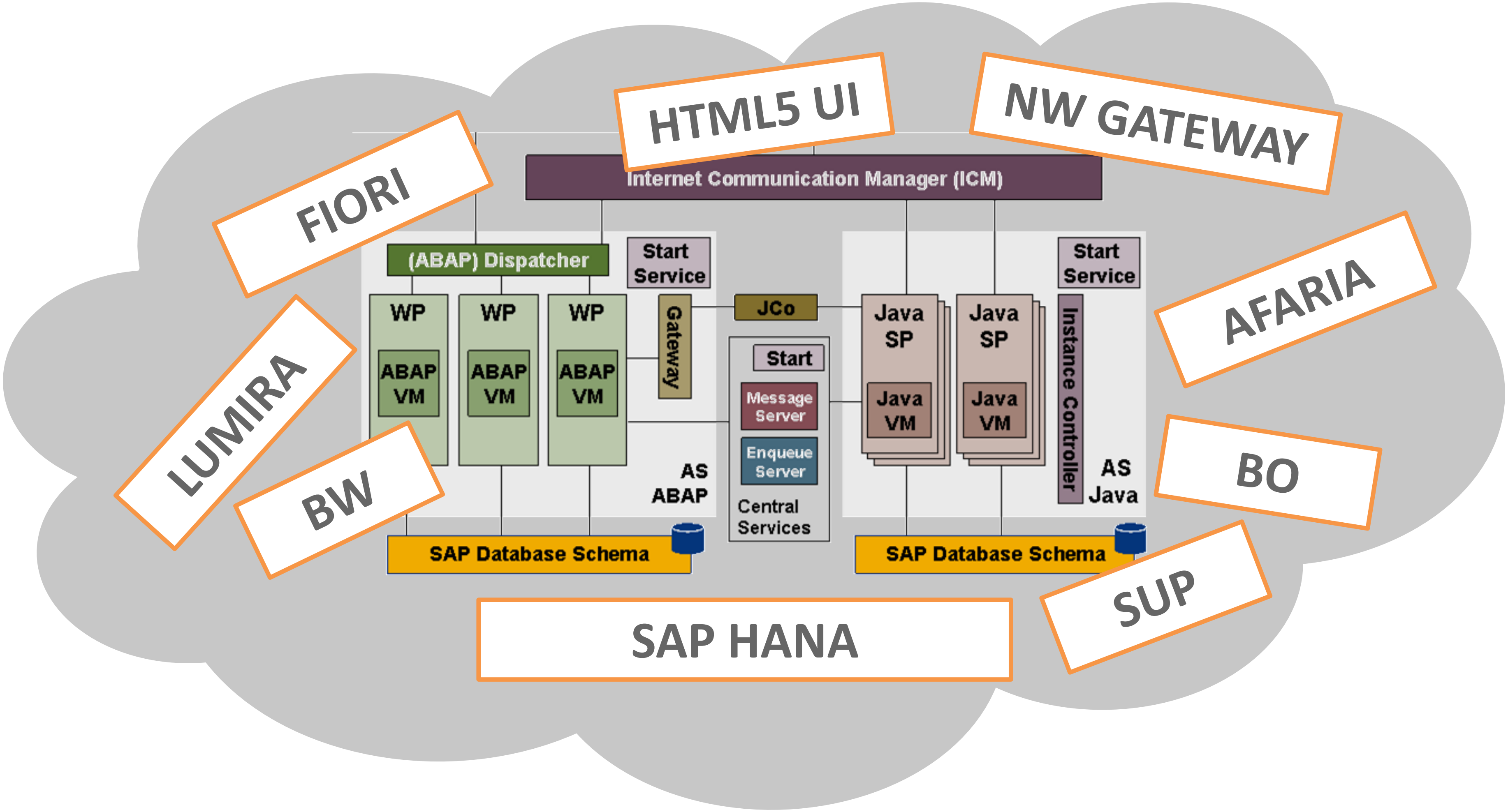


SAP GUI

Browser

API CLIENTS

MODERN SAP ENV



MODERN SAP ENV

SAP NETWEAVER GATEWAY

SAP HANA

SAP NW GATEWAY

REST API

INTEGRATION

ODATA/ATOM PROTOCOLS

ADD-ON FOR SAP NW ABAP

OData

SAP Netweaver Gateway and Odata

SAP HANA

IN-MEMORY DATABASE

PROTOCOL SPEC AVAILABLE

SAP HANA SQL Command Network Protocol

DISCOVERY & INFO GATHERING

SERVICE DISCOVERY

INFO DISCLOSURE

BRUTE FORCE ON AUTH SERVICES

VULN ASSESSMENT & EXPLOITATION

SNIFF/MITM

INVOLVE CLIENTS

ABUSE FUNCTIONS

SEVERAL RCE VULNS

REACH PRIVILEGE CONNECTION

SERVICE / PROTOCOL	DISCOVERY & INFO GATHERING	VULN ASSESS & EXPLOITATION
ROUTER	INFO REQUEST ~~INFO DISCLOSURE~~ INTERNAL NETWORK SCAN	SNIFF PROXY ~~HEAP OVERFLOW~~
GATEWAY/RFC	INFO BRUTE FORCE	~~RCE~~ SNIFF MONITOR RFC ATTACKS
DISPATCHER/DIAG	INFO BRUTE FORCE	~~RCE~~ SNIFF ROGUE SERVER ATTACK GUI USERS
MESSAGE SERVER	DUMP DATA MONITOR APP SERVERS	~~RCE~~ MONITOR IMPERSONATE ~~BUFF OVERFLOW~~ ~~MEMORY CORRUPTION~~
ENQUEUE SERVER	INFO	~~TRANSFER FILES~~ ~~SERVER CRASHES~~ ???

DEFENSE

TEST, TEST AND TEST

PATCH, PATCH AND PATCH

USE ENCRYPTED CHANNELS

ENABLE AND MONITOR LOGS

RESTRICT ACLs ON ALL SERVICES

CONCLUSIONS

NEW & RECENT ATTACKS

OLD ATTACKS PRACTICAL

DEFENSE & HARDENING

MORE PROTOCOL’S DETAILS

Q&A

Thank you !

mgallo@coresecurity.com

Thanks to

Diego, Sebas, Ivan, Francisco, Dana and Euge

Cover photo © Marcelo Schiavon

UPDATED TOOLS

pysap & wireshark plugin v0.1.4

+ PROTOCOLS
+ EXAMPLES
+ IMPROVEMENTS & FIXES

THANKS JORIS, FLORIAN, DAVE, DANIEL & ARNOLD

FOR VALUABLE FEEDBACK AND BUG REPORTS

pysap

Wireshark plugin

UPDATED TOOLS

pysap & wireshark plugin v0.1.4

STILL NEED WORK ON:

BUGFIXES AND TEST

IMPROVE: RFC, DIAG

NEW PROTOCOLS: P4? HANA?

MORE EXAMPLES AND ATTACKS

SUPPORT FOR + SAP GUI/NW VERSIONS

pysap

Wireshark plugin

UPDATED TOOLS

NMAP SERVICE DISCOVERY

IMPROVED/ADDED SERVICE PROBES FOR THE SERVICES REVIEWED:

SAPROUTER, DISPATCHER/DIAG, MS, ENQUEUE, GW/RFC