

# Wireless Internet: Layers 3,4,5

## Case Study: WAP

### Module W.int.3.WAP

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# Wireless Internet: layers 3,4,5

- ❑ Internet + wireless + mobility
- ❑ Mobile IP: network layer, module W.int.1
- ❑ Wireless TCP: transport layer, module W.int.2
- ❑ WAP: application layer
  - Wireless Application Protocol stack
  - WDP
  - WTLS
  - WTP
  - WSP
  - WAE
  - WML & WML Script
- ❑ End



# WAP: Wireless Application Protocol

## □ Goals

- Deliver Internet content and enhanced services to mobile devices and users (mobile phones, PDAs)
- Independent on wireless network standards

## □ Platforms

- GSM (900, 1800, 1900),
- CDMA IS-95,
- TDMA IS-136,
- 3<sup>rd</sup> generation systems (IMT-2000, UMTS, W-CDMA, cdma2000 1x EV-DO, ...)



# WAP: Wireless Application Protocol

- Forum
  - **Open Mobile Alliance** at [www.openmobilealliance.org](http://www.openmobilealliance.org)  
(Open Mobile Architecture + WAP Forum + SyncML + ...)
  
- What special about mobile devices?
  - Small displays, small memory capacity
  - No so powerful CPUs, limited network bandwidth
  - Relative high latency, unreliable connection
  - High mobility
  
- WAP-enabled devices, need I/O!
  - Micro-browser, output, for information viewing
  - Data input, e.g., number buttons or mini keyboard



# WAP: Wireless Application Protocol

- Open standard providing mobile users of wireless terminals access to telephony and information services
  - Wireless terminals include
    - ❖ Wireless phones, pagers, personal digital assistants (PDAs)
  - Designed to work with all wireless network technologies
    - ❖ GSM, CDMA, and TDMA
  - Based on existing Internet standards
    - ❖ IP, XML, HTML, and HTTP
  - Includes security facilities



# WAP: scope of standardization

## □ Browser

- "micro browser", similar to existing, well-known browsers in the Internet

## □ Script language

- similar to Java script, adapted to the mobile environment

## □ WTA(I)

- Wireless Telephony Application (Interface): access to all telephone functions

## □ Content formats

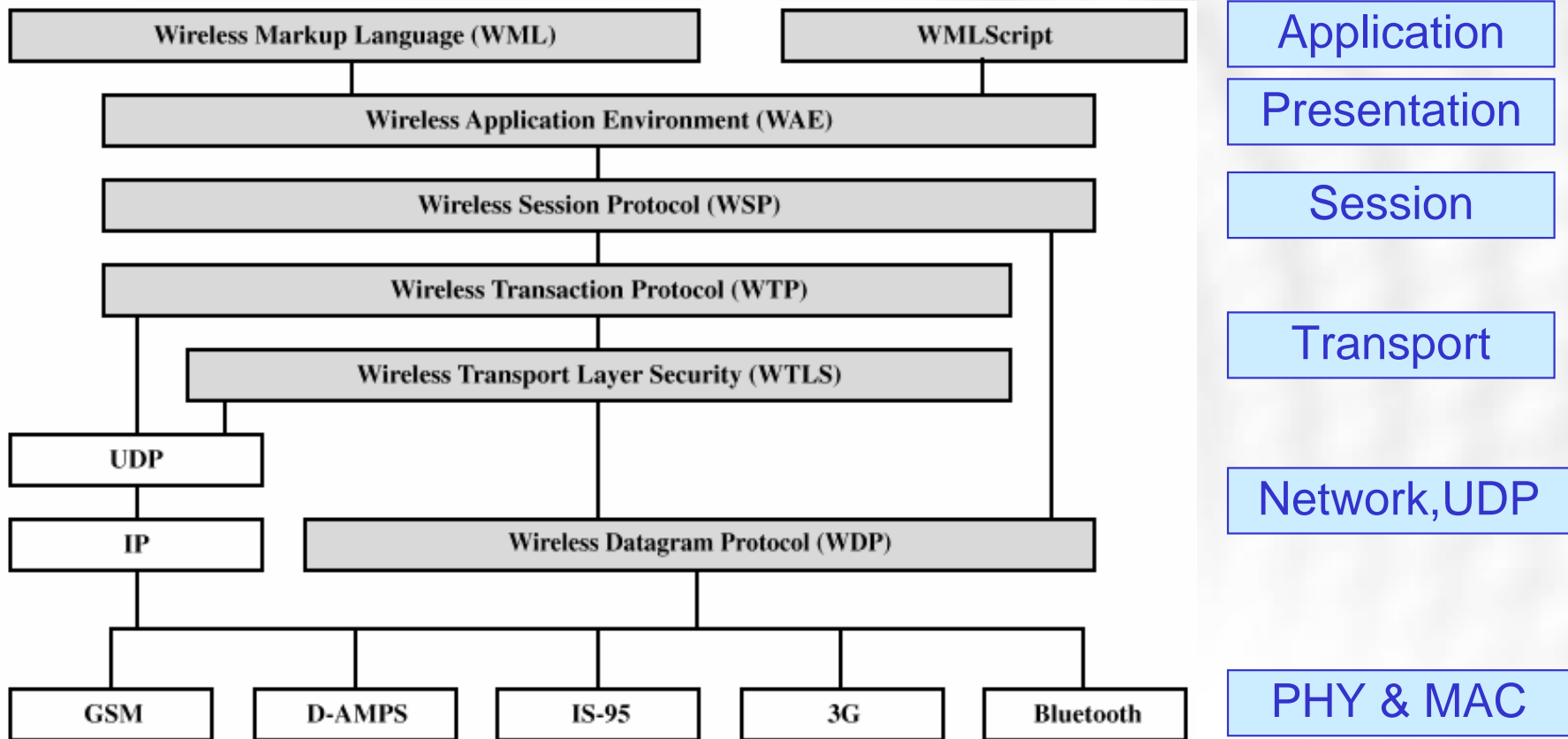
- e.g., business cards (vCard), calendar events (vCalender)

## □ Protocol layers

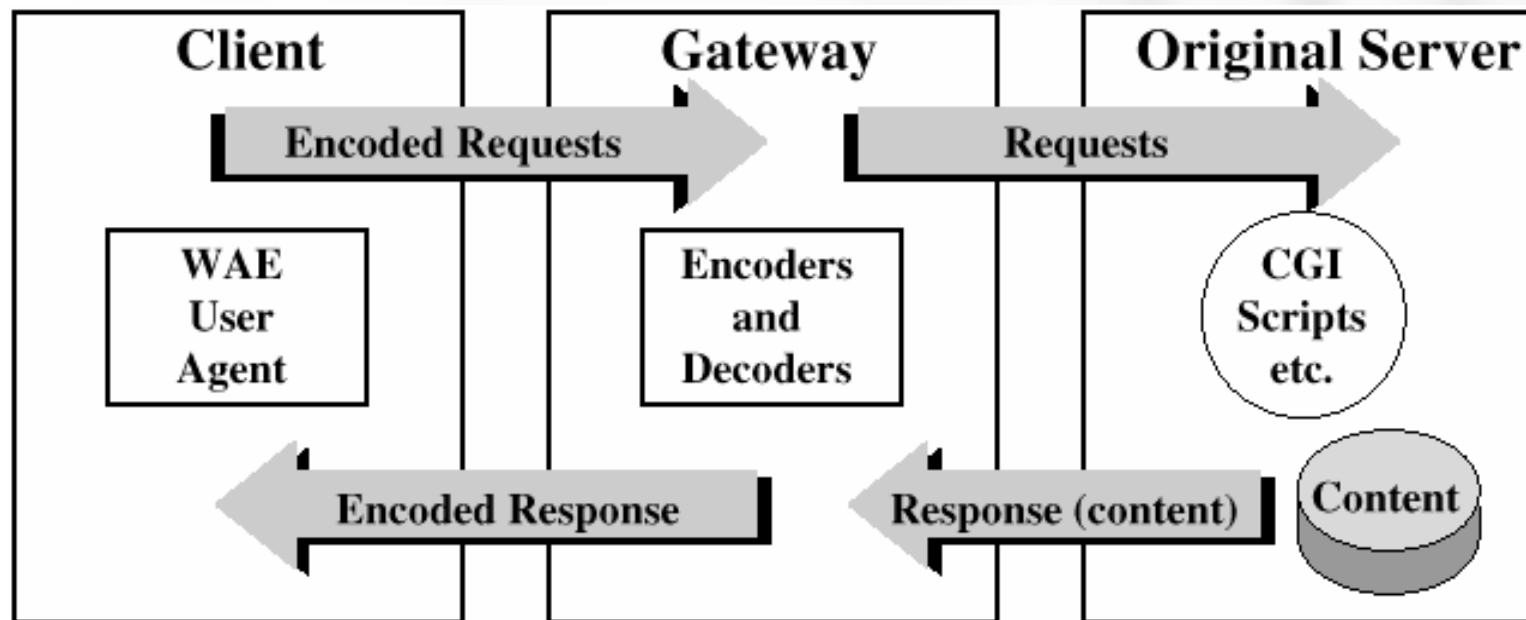
- transport layer, security layer, session layer etc.



# WAP: protocol stack



# WAP: programming model





# WDP: Wireless Datagram Protocol

- Protocol of the network/transport layer within the WAP architecture
  - uses directly transports mechanisms of different network technologies
  - offers a common interface for higher layer protocols
  - allows for transparent communication using different transport technologies
    - ❖ GSM [SMS, CSD, USSD, GPRS, ...],
    - ❖ IS-136, TETRA, DECT, PHS, IS-95, ...
- Goals of WDP
  - a worldwide interoperable transport system



# WDP: Wireless Datagram Protocol

- ❑ WDP hides details of the various bearer networks from the other layers of WAP
- ❑ Similar services as UDP
- ❑ Adaptation to high-layer WAP protocols
  - Partitioning data into segments of appropriate size for the bearer
  - Interfacing with the bearer network
- ❑ Format
  - Source/destination addresses, port numbers
  - Payload: user data



# WDP: Wireless Datagram Protocol

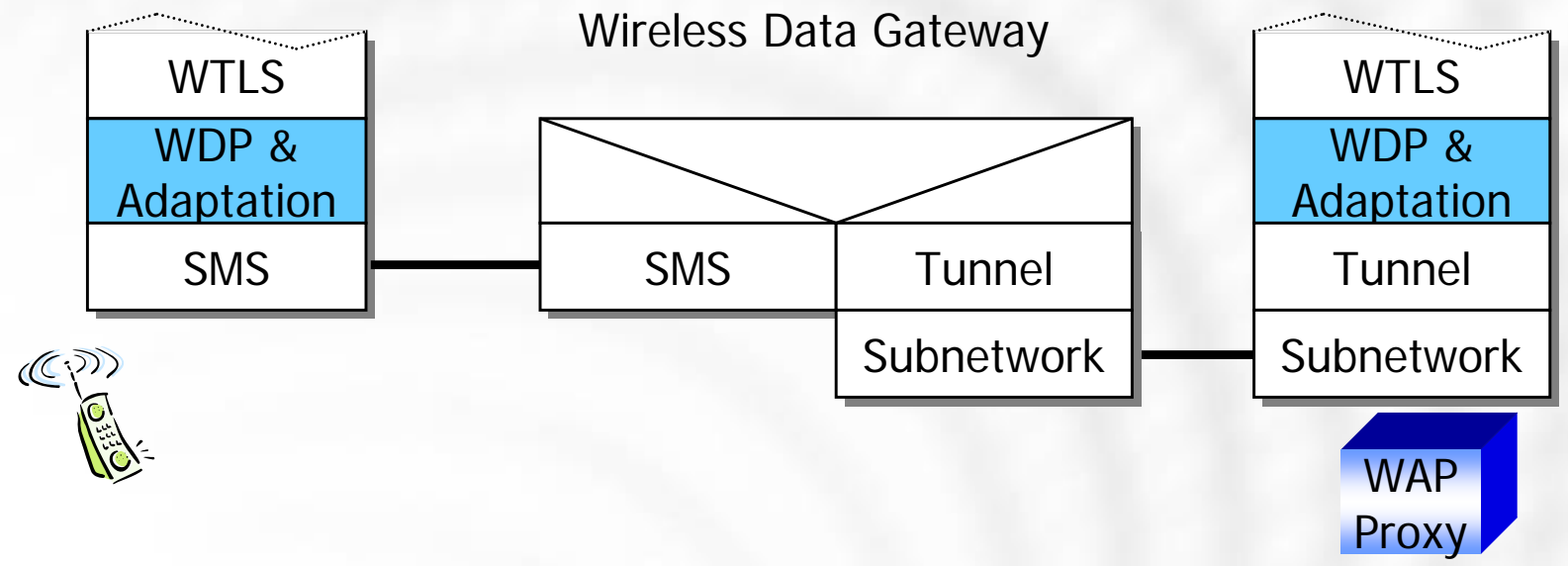
## □ WCMP (Wireless Control Message Protocol)

- Performs the same support function for WDP as ICMP does for IP
- Used in environments that don't provide IP bearer and don't lend themselves to the use of ICMP
- Used by wireless nodes and WAP gateways to *report/control errors* encountered in processing WDP datagrams
- Can also be used for informational and diagnostic purposes

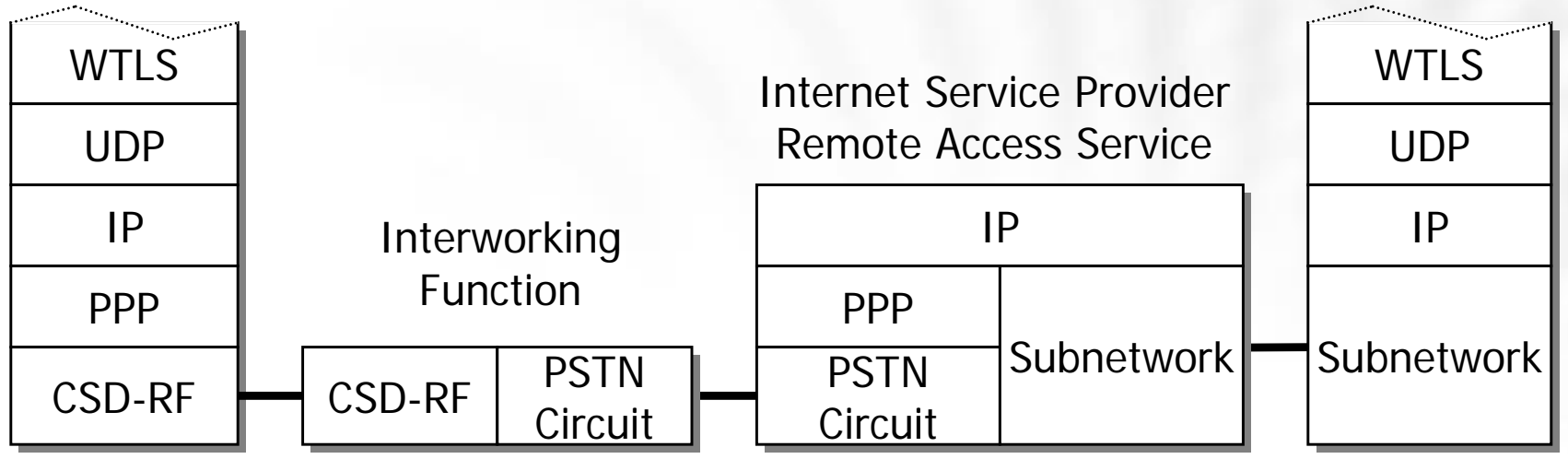


# WDP: how to use it?

GSM-SMS



GSM-CSD



# WTLS: Wireless Transport Layer Security

- Security services
  - Provided between WAP-enabled device and a WAP gateway
- Security features
  - Data integrity
    - ❖ ensures that data sent between client and gateway are not modified
    - ❖ using message authentication
  - Privacy
    - ❖ ensures that the data cannot be read by a third party
    - ❖ using encryption
  - Authentication
    - ❖ establishes authentication of the two parties
    - ❖ using digital certificates
  - Denial-of-service protection
    - ❖ detects and rejects messages that are replayed or not successfully verified



# WTLS: protocol stack

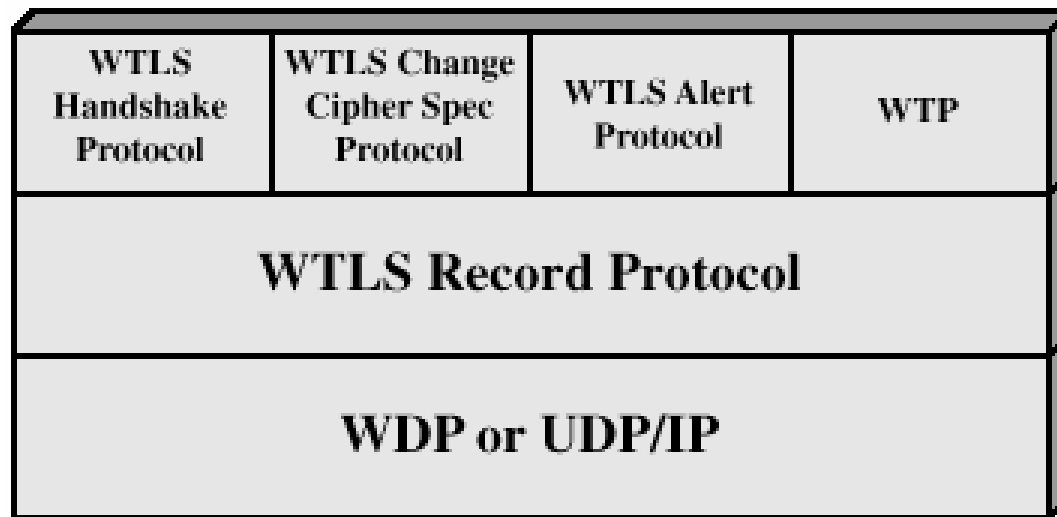
- WTLS consists of two layers of protocols

## 1. WTLS Record Protocol

- ❖ provides basic security services to various higher-layer protocols

## 2. Higher-layer protocols:

- ❖ the Handshake Protocol
- ❖ the Change Cipher Spec Protocol
- ❖ the Alert Protocol



# WTLS: protocol stack

- Record protocol operation

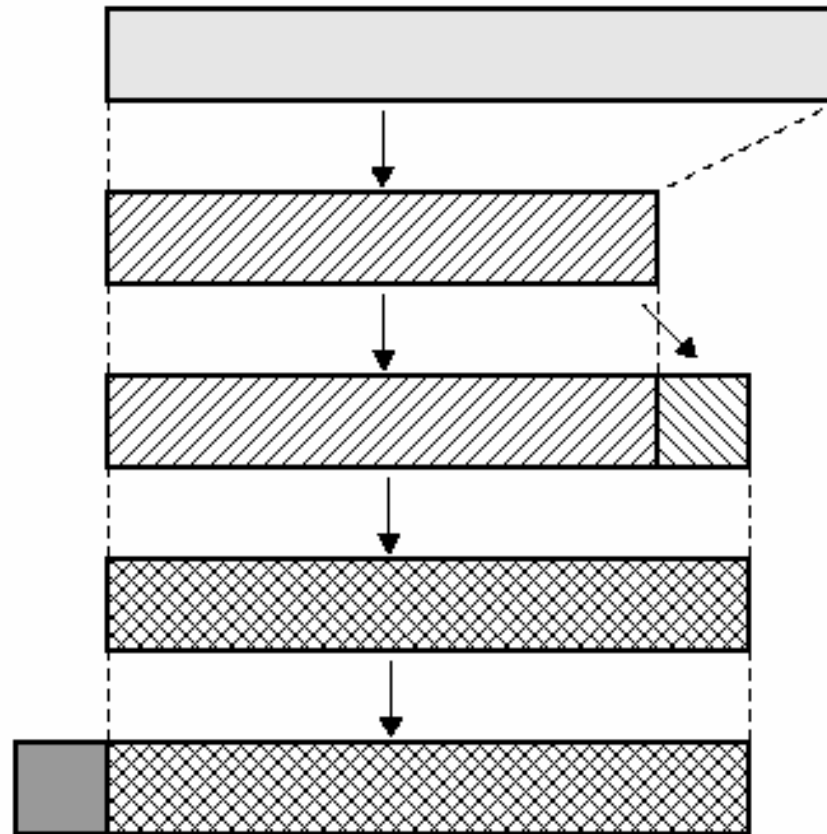
User Data

Compress

Add MAC

Encrypt

Append WTLS  
Record Header



# WTLS: protocol stack

## □ Handshake Protocol Exchange

- 1<sup>st</sup> phase
  - ❖ used to initiate a logical connection and establish security capabilities
- 2<sup>nd</sup> phase
  - ❖ used for server authentication and key exchange
- 3<sup>rd</sup> phase
  - ❖ used for client authentication and key exchange
- 4<sup>th</sup> phase
  - ❖ completes the setting up of a secure connection





# WTP: Wireless Transaction Protocol

## □ Lightweight protocol

- suitable for "thin" clients and over low-bandwidth wireless links
- A transaction is defined as a request with its response

## □ Three classes of transaction service

- Class 0: Unreliable one-way request, no retransmission
- Class 1: Reliable one-way request, resend if ACK not received
- Class 2: Reliable two-way request-response message

## □ WTP features

- Optional user-to-user reliability: WTP user triggers confirmation of each received message
- Optional out-of-band data on acknowledgments
- PDU concatenation and delayed acknowledgment to reduce the number of messages sent
- Asynchronous transactions



# WSP: Wireless Session Protocol

- Transaction-oriented protocol
  - based on the concept of a request and a reply
  
- Provides applications with interface for two session services:
  1. Connection-oriented session service
    - ❖ operates above reliable transport protocol WTP
  2. Connectionless session service
    - ❖ operates above unreliable transport protocol WDP



# WSP: Wireless Session Protocol

## 1. Connection-oriented session service

- Operates above reliable transport protocol WTP
- Establish reliable session from client to server and release
- Agree on common level of protocol functionality using capability negotiation
- Exchange content between client and server using compact encoding
- Suspend and resume a session
- Push content from server to client in a unsynchronized manner



# WSP: Wireless Session Protocol

## □ WSP transaction types

- Session establishment
  - ❖ client WSP user requests session with server WSP user
- Session termination
  - ❖ client WSP user initiates termination
- Session suspend and resume
  - ❖ initiated with suspend and resume requests
- Transaction
  - ❖ exchange of data between a client and server
- Nonconfirmed data push
  - ❖ used to send unsolicited information from server to client
- Confirmed data push
  - ❖ server receives delivery confirmation from client

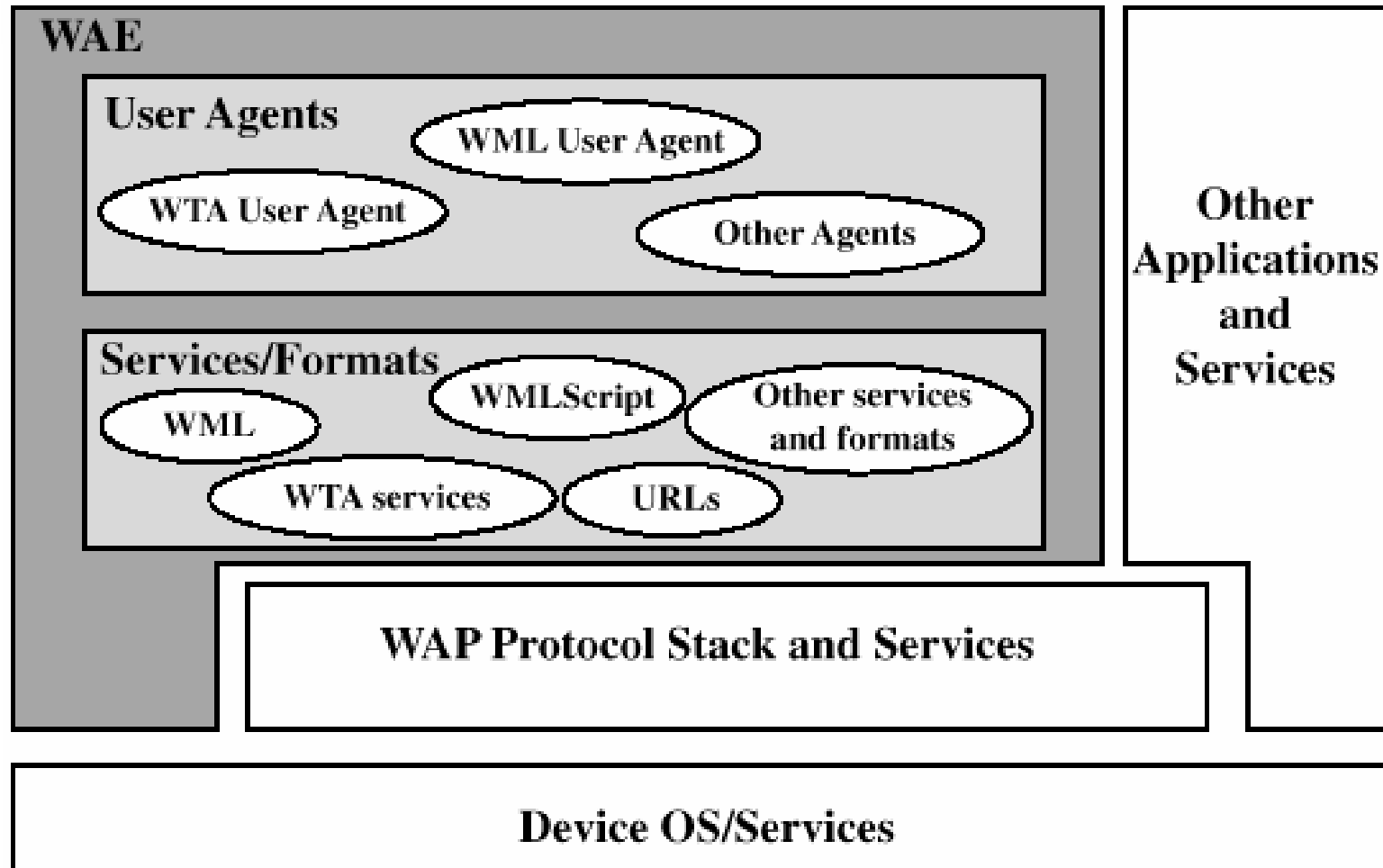


# WAE: Wireless Application Environment

- WAE specifies an application framework for wireless devices
- WAE elements:
  - WAE User agents - software that executes in the wireless device
  - Content generators - applications that produce standard content formats in response to requests from user agents in the mobile terminal
  - Standard content encoding - defined to allow a WAE user agent to navigate Web content
  - Wireless telephony applications (WTA)
    - ❖ collection of telephony-specific extensions for call and feature control mechanisms



# WAE: client components



# WML: Wireless Markup Language

- ❑ Text and image support - formatting and layout commands
- ❑ A WML document consists of multiple cards
  - Each card represents a screen of information
- ❑ Cards can be grouped together in a deck
  - A WML deck is similar to an HTML page
  
- ❑ Deck/card organizational metaphor
  - WML documents subdivided into cards, which specify one or more units of interaction
  - Support for navigation among cards and decks
    - ❖ includes provisions for event handling;
    - ❖ used for navigation or executing scripts



# WML Script

- A complement to WML
  - Scripting language for defining script-type programs
  - in a user device with limited processing power and memory
- WMLScript capabilities:
  - Check validity of user input before it's sent
  - Access device facilities and peripherals
  - Interact with user without introducing round trips to origin server
- WMLScript features:
  - JavaScript-based scripting language
  - Procedural logic, event-based
  - Compiled implementation
  - Integrated into WAE





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