ITU - Definition

A Next Generation Network (NGN) is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

Next Generation Network ??

ITU - Definition

The NGN is characterized by the following fundamental aspects:

- Packet-based transfer
- Separation of control functions among bearer capabilities, call/session, and application/ service
- Decoupling of service provision from network, and provision of open interfaces
- Support for a wide range of services, applications and mechanisms based on service building blocks (including real time/ streaming/ non-real time services and multi-media)
- Broadband capabilities with end-to-end QoS and transparency
- Interworking with legacy networks via open interfaces
- Generalized mobility
- Unrestricted access by users to different service providers
- A variety of identification schemes which can be resolved to IP addresses for the purposes of routing in IP networks
- Unified service characteristics for the same service as perceived by the user
- Converged services between Fixed/Mobile
- Independence of service-related functions from underlying transport technologies
- Compliant with all Regulatory requirements, for example concerning emergency communications and security/privacy, etc.

Next Generation Network ??

LTE-EPC AND IMS REFERENCE 23.228

PROTOCOLS	
BICC	(SS7) Bearer Independent Call Control, ITU-T, Q.1901
Diameter	RFC 3588, RFC 3589, RFC 4006, RFC 4740
GTPv2-C	GPRS Tunneling Protocol ver.2 Control Plane, 29.274
GTPv1-U	GPRS Tunneling Protocol User Plane, 29.281
HTTP	Hypertext Transfer Protocol, RFC 2616
IP	Internet Protocol, RFC 791
ISUP	(SS7) ISDN User Part, ITU-T. Q.763
L1	(SS7) Layer 1 (unspecified)
M3UA	MTP3 User Application Layer, RFC 3332
MEGACO	Media Gateway Control Protocol, RFC 3525
MTP2	(SS7) Message Transfer Part 2, ITU-T Q.703
MTP3	(SS7) Message Transfer Part 3, ITU-T Q.703
RTP	Real-Time Transport Protocol, RFC 3550
S1AP	S1 Application Part, 36.413
SIP	Session Initiation Protocol, RFC 3261
SCTP	Streaming Control Transmission Protocol, RFC 3708
TCP	Transmission Control Protocol, RFC 793
TDM	(PSTN) Time Division Multiplexing
UDP	User Datagram Protocol, RFC 768
Not Specified	Not Specified (proprietary)

Interfaces LEGEND

- LTE Traffic and Signaling
- User Traffic (indeterminate)
- LTE Signaling
- IMS Media Plane
- IMS Session Control Plane
- IMS Media Control
- Service Control
- IMS Application Plane
- PSTN Signaling
- Virtual Interfaces (different colors)

3GCF (another network)

BGCF 23.002

23.228, Section 5.5 MGCF

GW 23.002

CPE

PSTN

PLMN

SS7

HSS 23.002

36.300 MME

SPR 23.002

UE

E-UTRAN

Subscriber's service management

UE's SIP-based registrations and session control

IMS-based media stream

Public Internet Access

23.228, Annex P MRFP

23.228, Annex P MRFC

MGW 23.002

23.228, Section 4 AS

PCRF 23.203

23.228, Section 5 I-CSCF

S-CSCF 23.228, Section 5

P-GW (PCEF) 23.002; 23.401; 23.402

P-CSCF 23.228, Section 5

S-GW 23.002

Default Bearer #2

Dedicated Bearer

Default Bearer #1

DNS ENUM RFC 3761

HSS 23.002; 23.228, Annex H

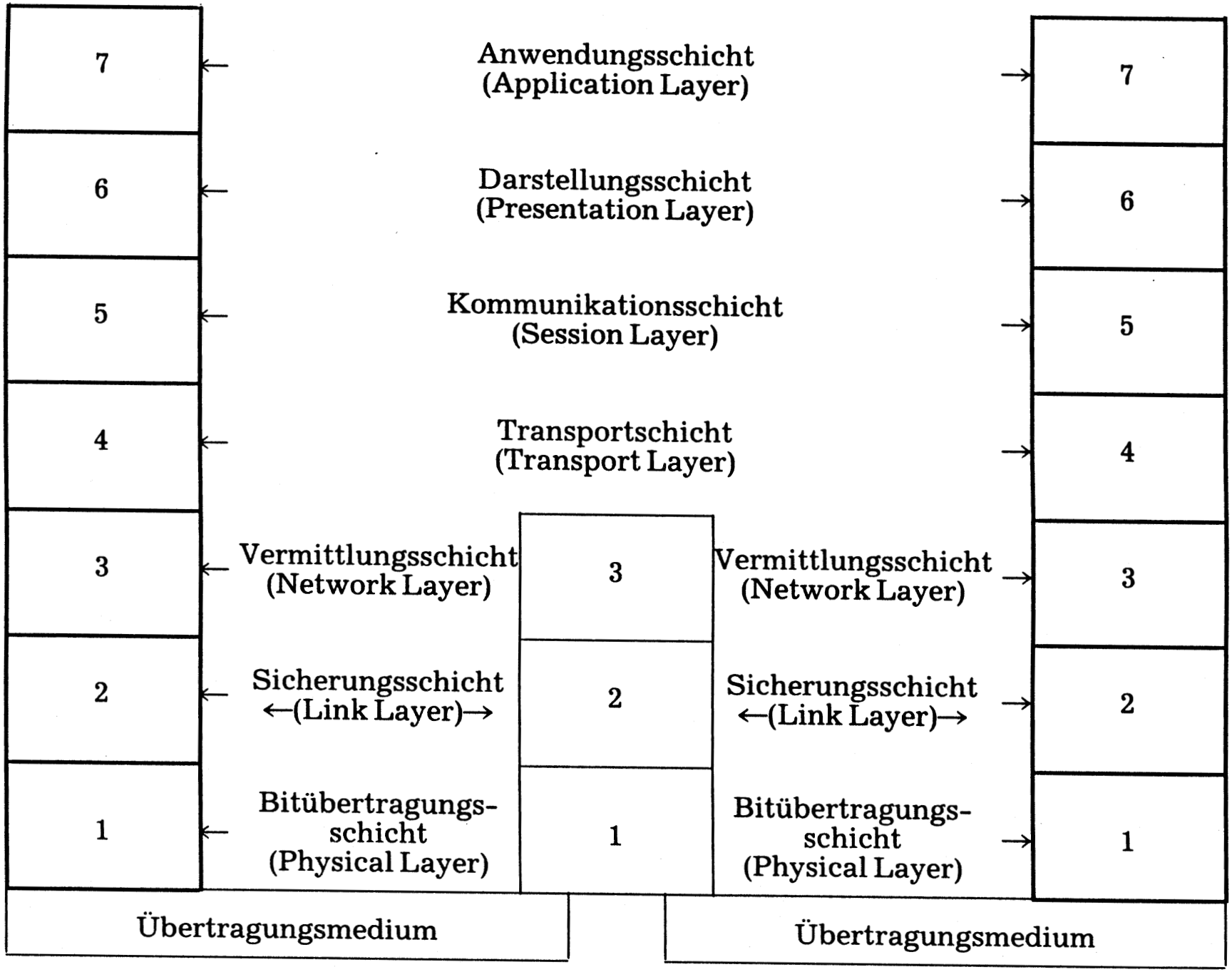
IP Network

Acronyms and Nodes

3GPP	Third Generation Partnership Project
AF	Application Function
AS	Application Server
BGCF	Border Gateway Control Function
CPE	Customer Premise Equipment
DNS	Domain Name System
ENUM	E.164 Number Mapping
HSS	Home Subscriber Server
IMS	IP Multimedia Subsystem
I-CSCF	Interrogating Call Session Control Function
ISC	IMS Service Control
LTE	Long Term Evolution
MGCF	Media Gateway Control Function
MGW	Media Gateway
MRFC	Media Resource Function Controller
MRFP	Media Resource Function Processor
PCEF	Policy and Charging Enforcement Function
PCRF	Policy and Charging Rules Function
P-CSCF	Proxy Call Session Control Function
PDN	Packet Data Network
P-GW	PDN Gateway
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
SGW	Signaling Gateway
S-GW	Serving Gateway
S-CSCF	Serving Call Session Control Function
SPR	Subscription Profile Repository
UE	User Equipment

3GPP Interfaces and Technical Specifications

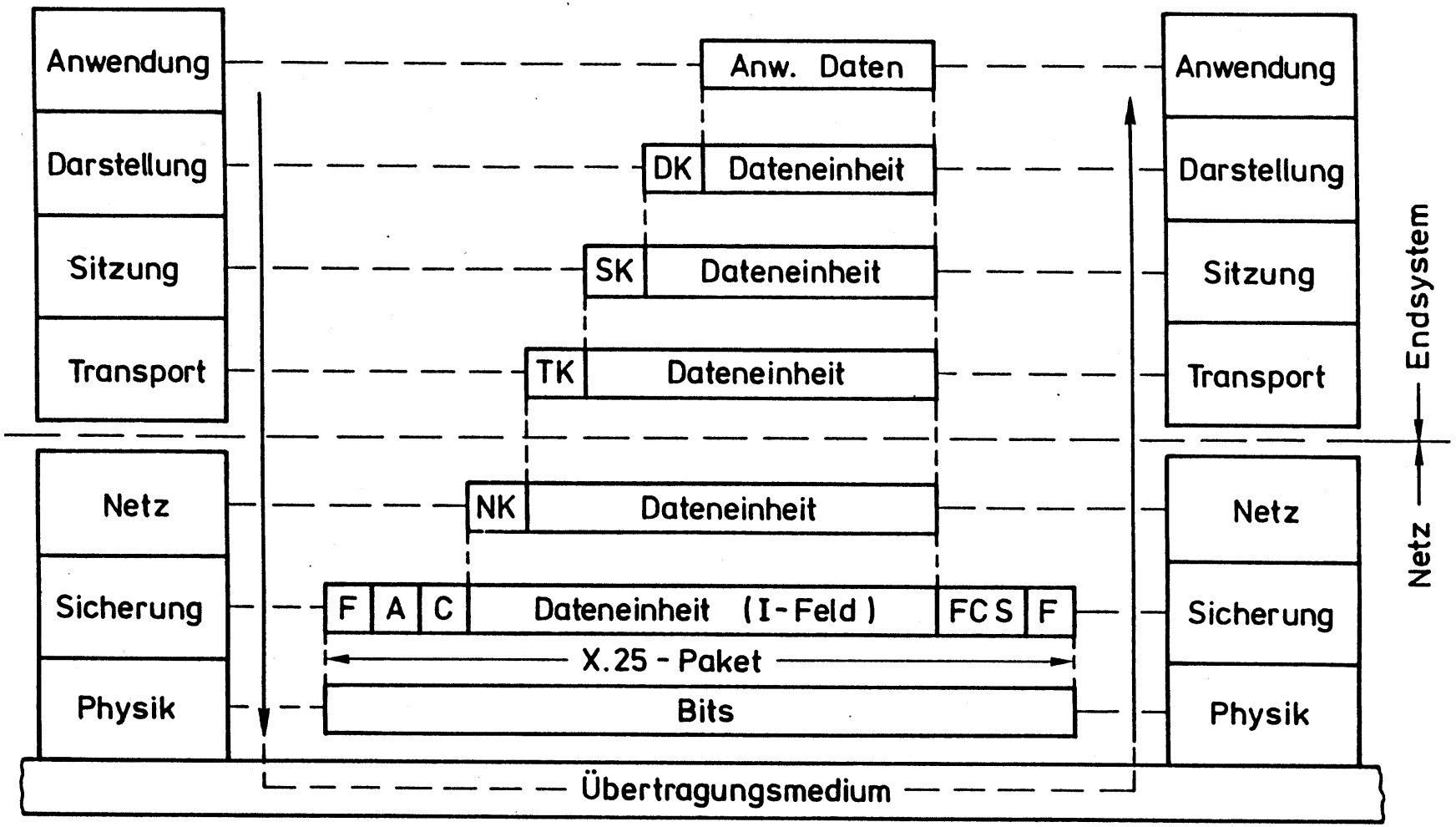
Interface	Nodes	Technical Specifications
Cx	CSCF HSS	29.228, 29.229
Gm	UE P-CSCF	RFC 3261
Gx	PCEF PCRF	29.212, 23.203
ISC	S-CSCF AF	23.228, RFC 3455, RFC 3325
Mb	RTP-based Bearer	29.162, TR 23.899, RFC 4867
Mg	MGCF CSCF	RFC 3261
Mi	CSCF BGCF	RFC 3261
Mj	BGCF MGCF	RFC 3261
Mn	MGCF MGW	RFC 3525
Mp	MRFC MRFP	RFC 3525
Mr	S-CSCF MRFC	RFC 3261
Mw	I-CSCF, P-CSCF, S-CSCF	RFC 3261
Rx	AF PCRF	23.203, 29.214
S1AP	EUTRAN (eNB) MME	36.410
S1-U	EUTRAN (eNB) SGW	36.401, 36.410
S5	S-GW PGW	29.274 (control plane) 29.281 (user plane)
S6a	MME HSS	29.272
S11	MME SGW	29.274
SGi	P-GW PDN	29.061
Sh	HSS SPR	29.328, 29.329
Sp	SPR PCRF	29.203, 29.328, 29.329
Ut	UE AF	RFC 2616



OSI-Schichtenmodell

Schicht	Funktionen
Anwendung **7**	Identifikation der Kommunikationspartner Beurteilung der momentanen Verfügbarkeit der Kommunikationspartner Berechtigungsprüfung für Kommunikation Wahl der Übermittlungsparameter (Dienstqualität, Priorität usw.) entsprechend Anwendung
Darstellung **6**	Code- und Alphabetwandlung Formatanpassung Wahl der geeigneten Syntax entsprechend Anwendung
Sitzung **5**	Aufbau und Aufrechterhaltung logischer Verbindungen (Zuordnung) zwischen bestimmten Verarbeitungseinheiten Verbindungsidentifikation Dialogsteuerung
Transport **4**	Aufbau und Überwachung von Duplex-Übermittlungspfaden Anpassung an unterschiedliche Netzeigenschaften End-zu-End-Fehlerkontrolle Segmentierung und Blockbildung Adressübersetzungen
Netz **3**	Verbindungslenkung Aufbau und Überwachung von Netzverbindungen Verbindungsmultiplexierung Netzabhängige Fehlerüberwachung Flußsteuerung, Verwaltung der Netzressourcen
Leitung **2**	Leitungsaktivierung/-deaktivierung Übertragungssteuerung Übertragungsfehlerüberwachung Blocksynchronisation Wahl des geeigneten von mehreren physischen Übertragungspfaden
Physische Übertragung **1**	Parallel/Serie-Wandlung Anpassung an die Physik unterschiedlicher Übertragungsmedien Synchronisation von Informationselementen (Bits) Zusammenschaltung von Abschnitten unterschiedlicher Übertragungsmedien Zustandsüberwachung und -signalisation

Funktionen der OSI - Schichten



DK Darstellungskopf
SK Sitzungskopf
TK Transportkopf
NK Netzkopf
F Blockbegrenzung (flag)

A Adreßfeld (address field)
C Steuerfeld (control field)
FCS Blockprüfzeichenfolge (frame check sequence)

Einbetten von PDUs höherer Schichten in unterlagerte Schichten

Definition of a Distributed System (1)

A distributed system is:

A collection of independent computers that appears to its users as a single coherent system.

Definition of a Distributed System (2)

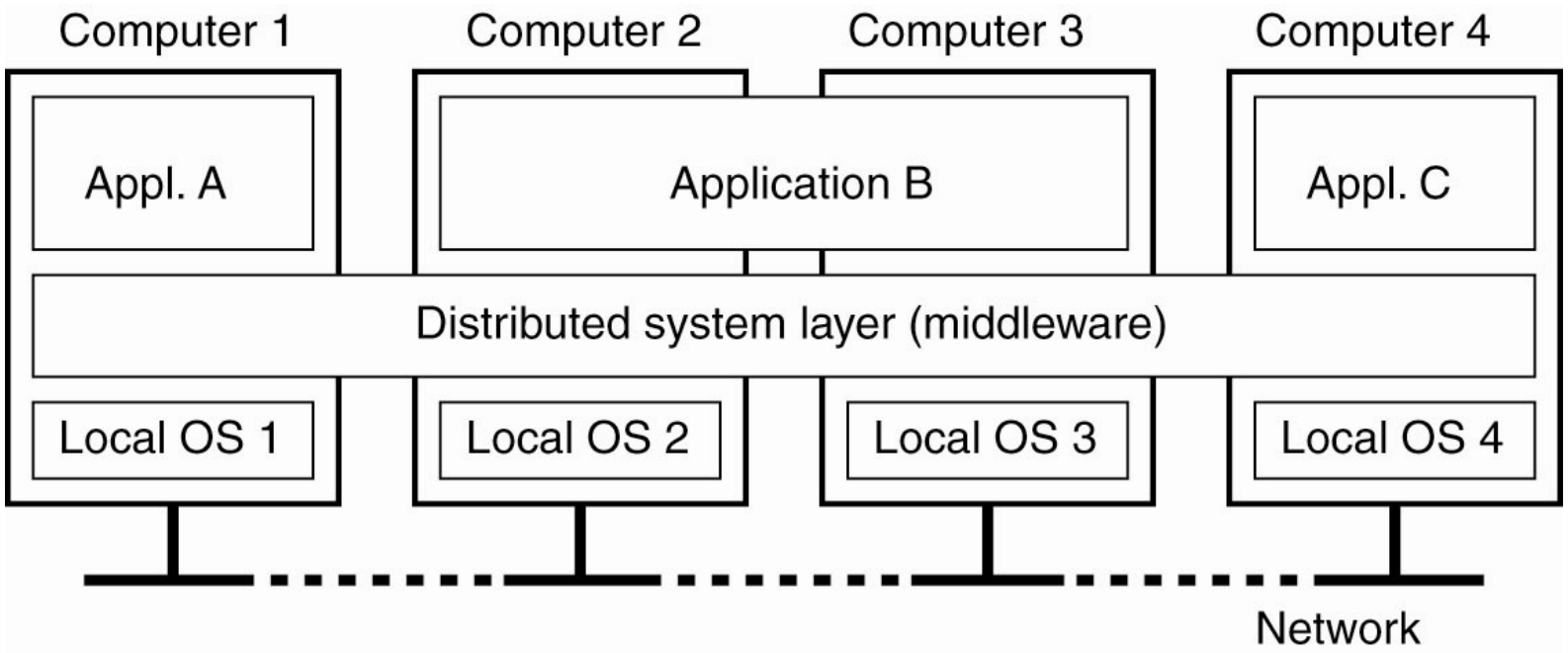


Figure 1-1. A distributed system organized as middleware. The middleware layer extends over multiple machines, and offers each application the same interface.

Transparency in a Distributed System

Transparency	Description
Access	Hide differences in data representation and how a resource is accessed
Location	Hide where a resource is located
Migration	Hide that a resource may move to another location
Relocation	Hide that a resource may be moved to another location while in use
Replication	Hide that a resource is replicated
Concurrency	Hide that a resource may be shared by several competitive users
Failure	Hide the failure and recovery of a resource

Figure 1-2. Different forms of transparency in a distributed system (ISO, 1995).

Scalability Problems

Concept	Example
Centralized services	A single server for all users
Centralized data	A single on-line telephone book
Centralized algorithms	Doing routing based on complete information

Figure 1-3. Examples of scalability limitations.

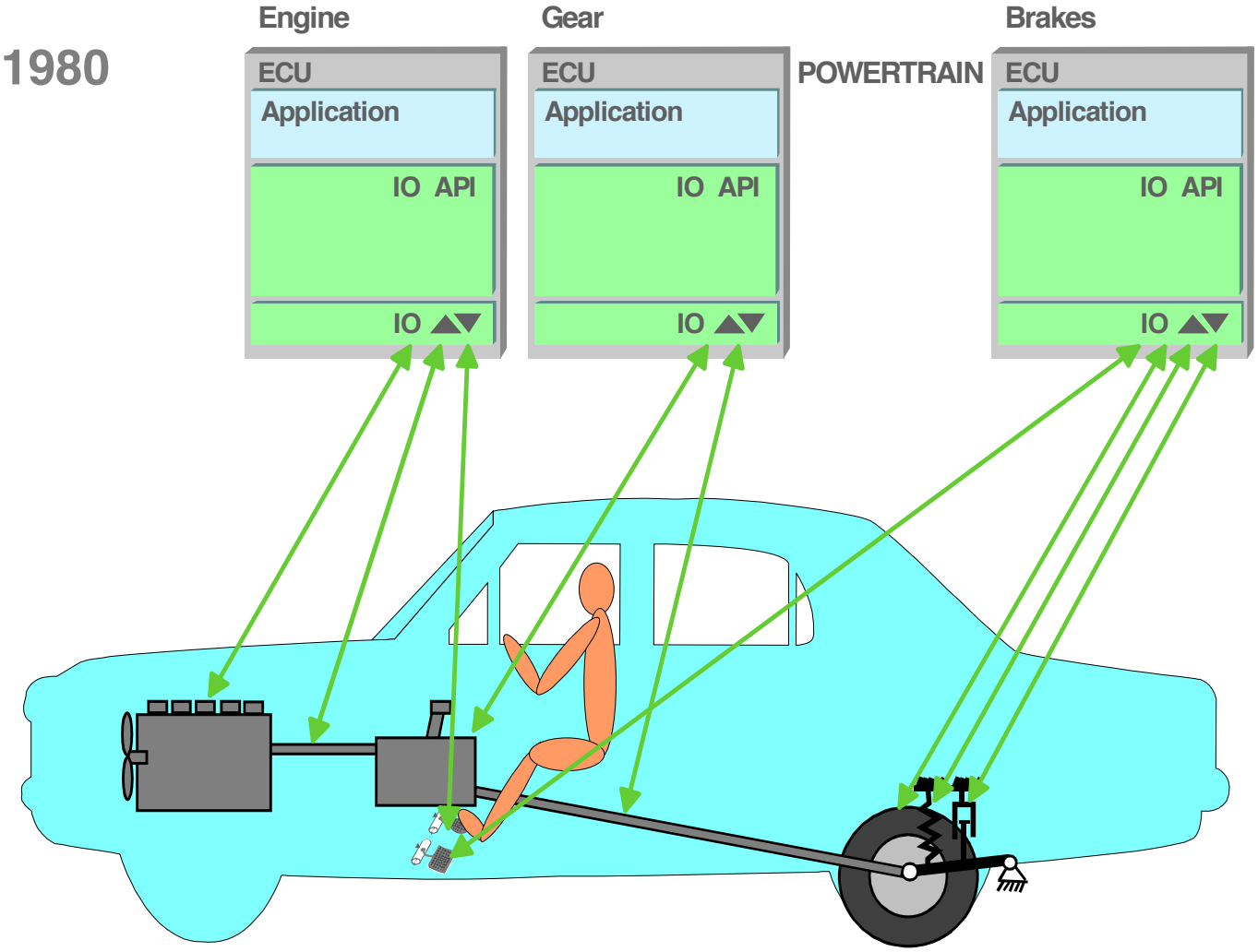
Scalability Problems

Characteristics of decentralized algorithms:

- No machine has complete information about the system state.
- Machines make decisions based only on local information.
- Failure of one machine does not ruin the algorithm.
- There is no implicit assumption that a global clock exists.

Vehicles Technology Evolution
- Mechanics + Isolated Electronics Control

Year 1980



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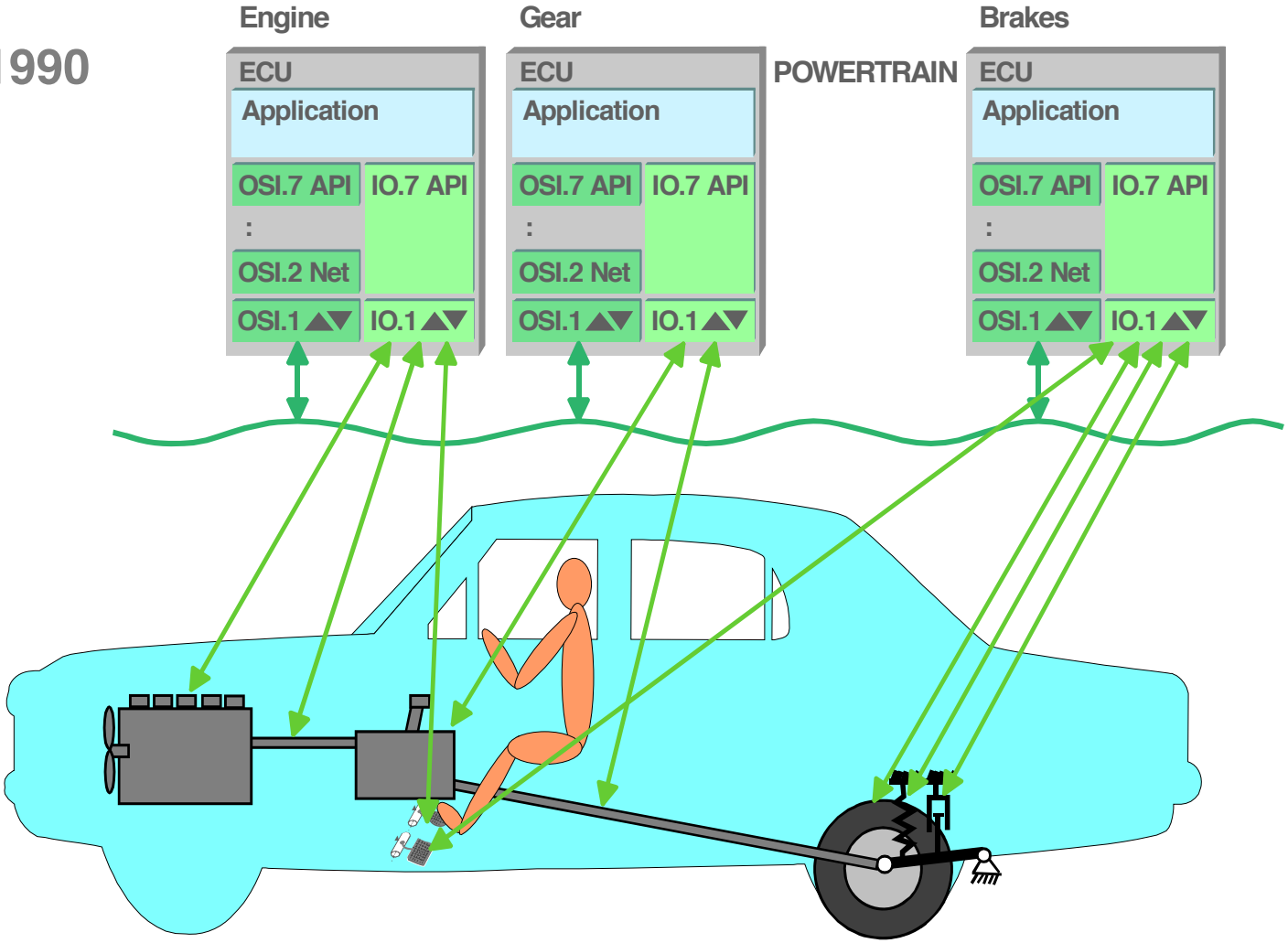
Fachhochschule Braunschweig/Wolfenbüttel

Vehicle Systems Architecture
- Mechanics + Electronics Ctrl + Network Com

Year 1990



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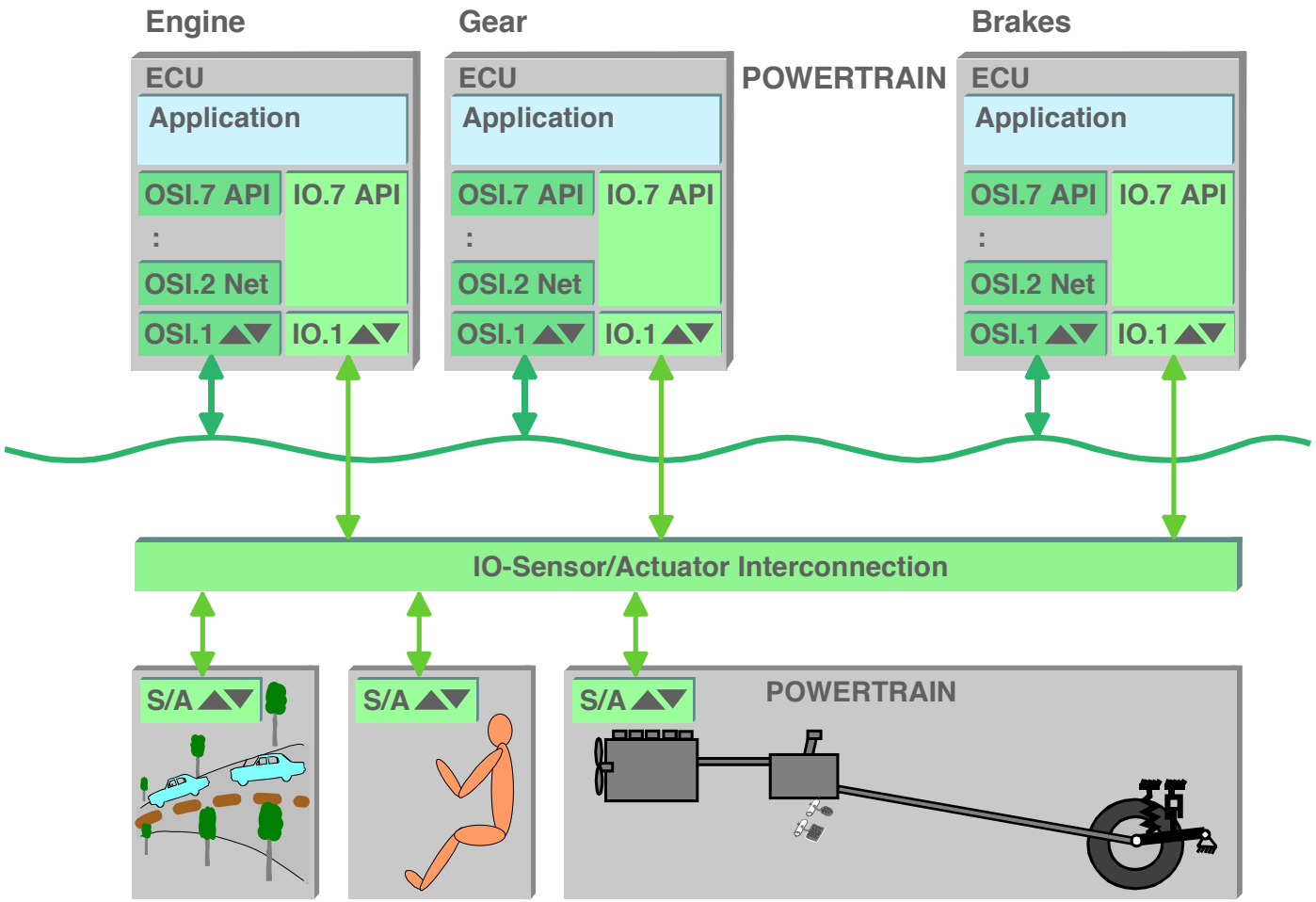
Vehicles Technology Evolution – abstract view - Mechanics + Electronics Ctrl + Network Com



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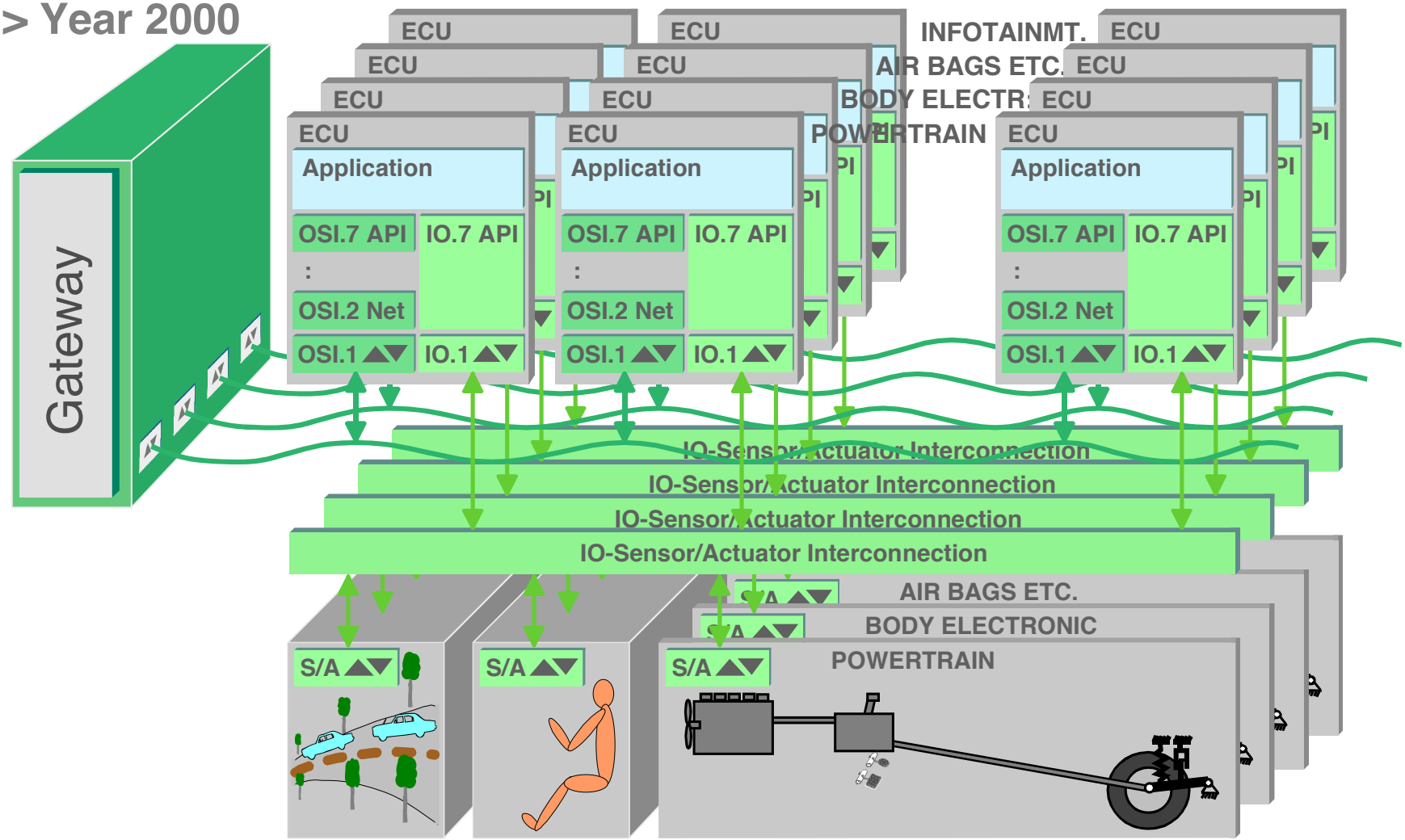
Vehicles Technology Evolution – abstract view
- Mechanics + Electronics Ctrl + MultiNet Com
> Year 2000



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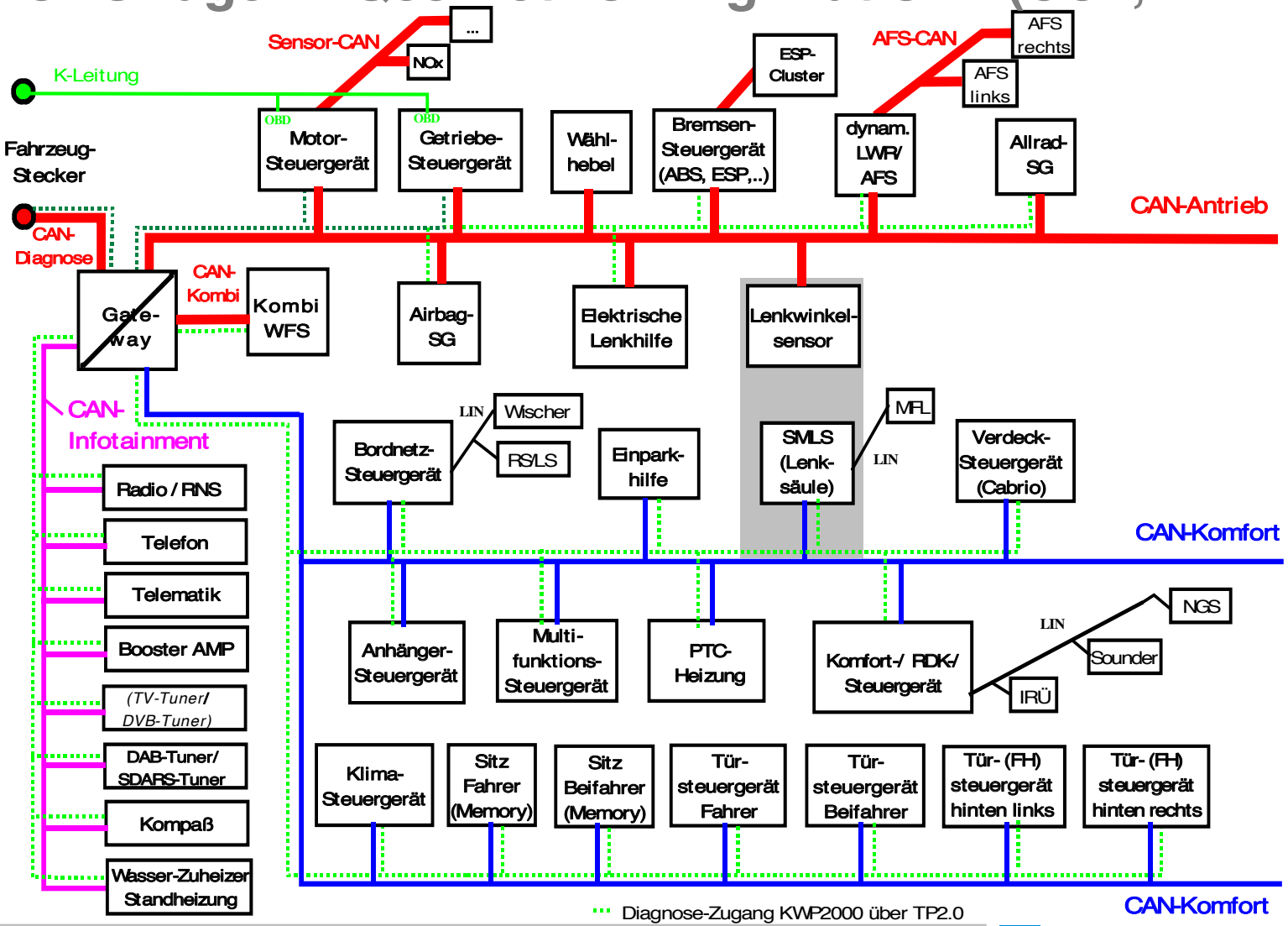
Automotive Networked System
Volkswagen PQ35 Networking Platform (Golf, ... Phaeton)



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Introduction

Future In-Vehicle Network Architecture

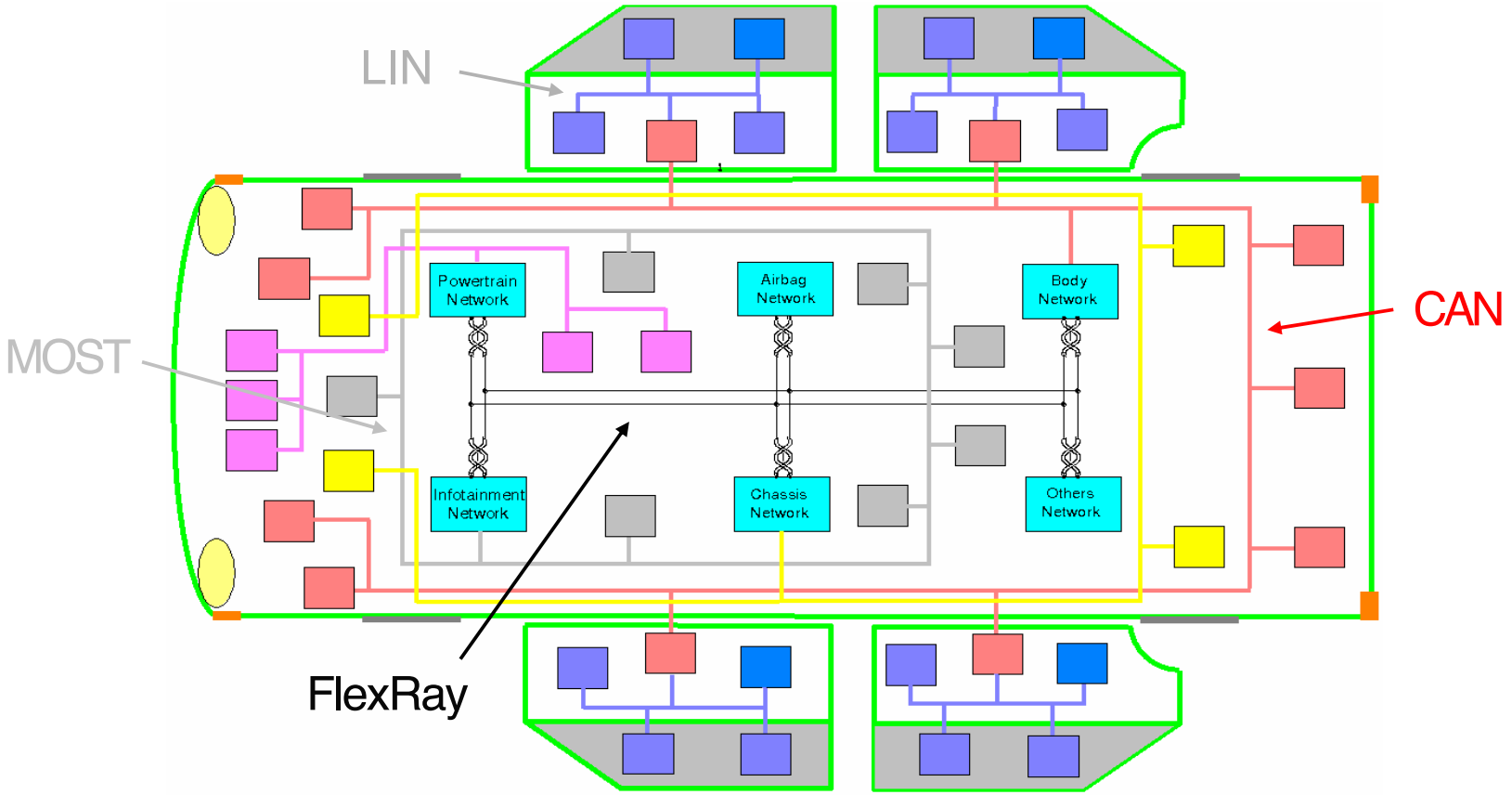

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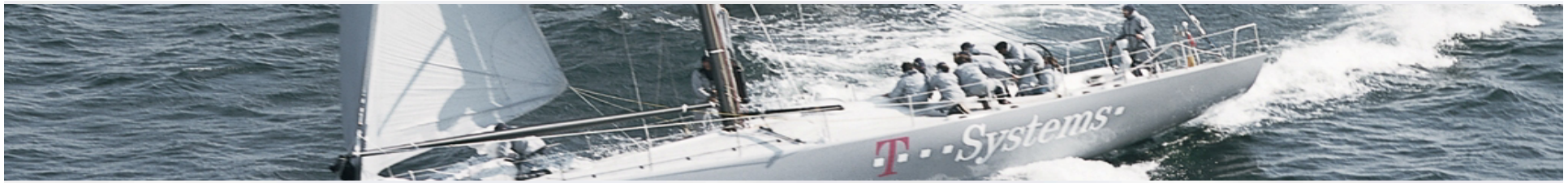
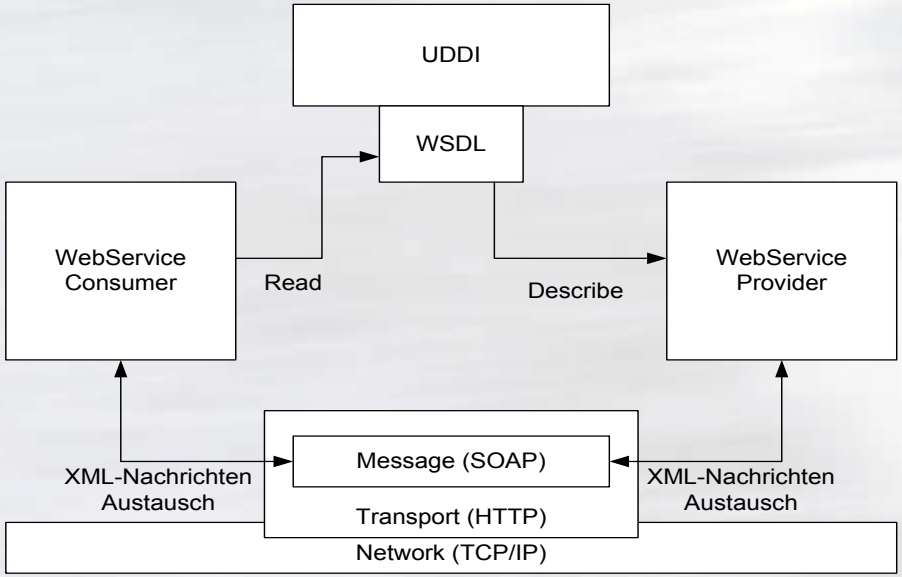
Illustration Mobile Ad-Hoc Network (MANET)

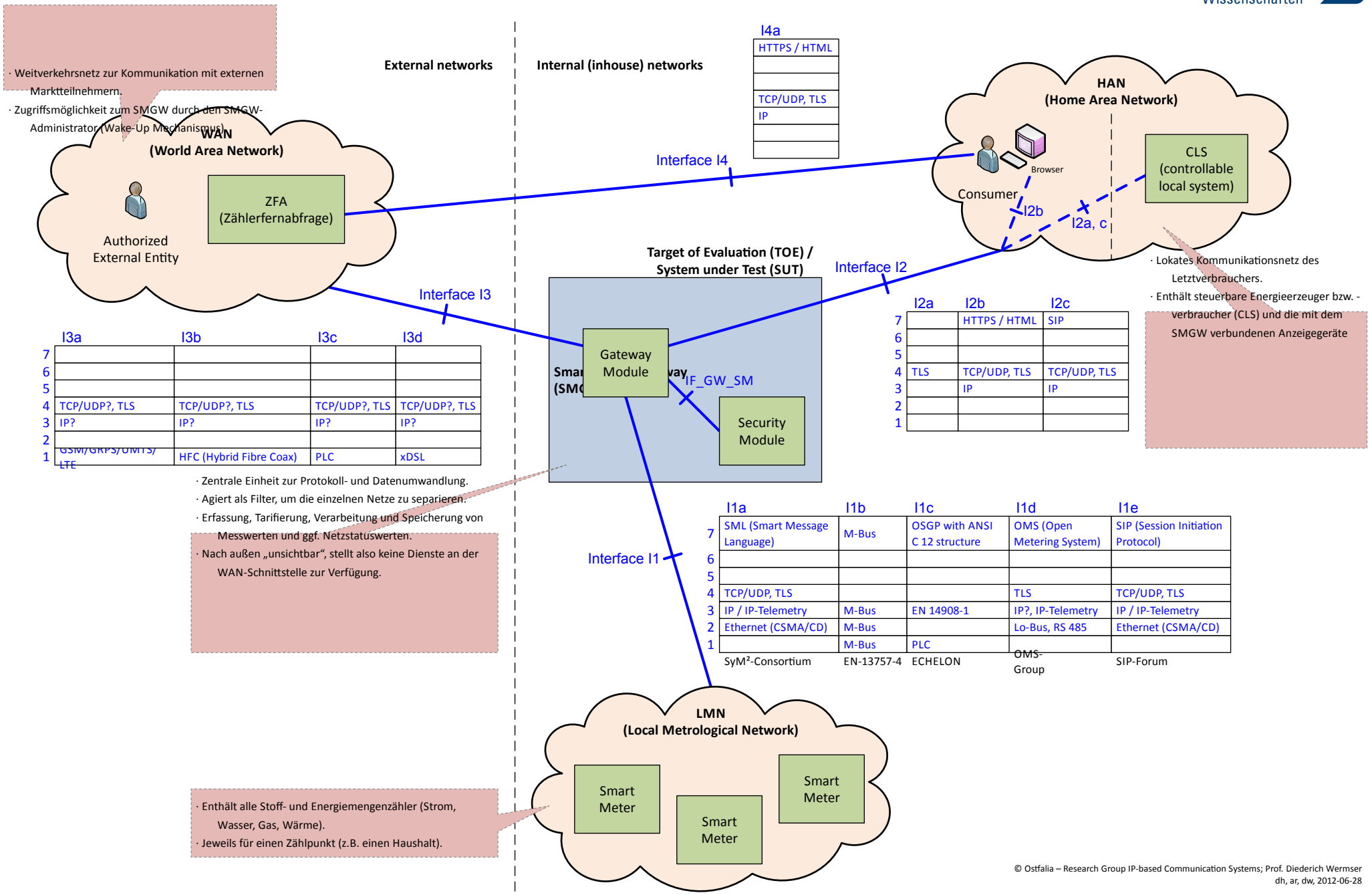
Service Oriented Architecture



- SOA ist ein Systemarchitektur Konzept
  - Basiert auf den Nachrichtenbasierten verteilten Systemen
  - Bietet Applikationen als WebServices an



- UDDI: Universal Description, Discovery and Integration
  - Verzeichnis-Dienst
- WSDL: WebServices Description Language
  - Auf XML basierend
  - dient der Beschreibung von Services
- SOAP
  - Protokoll zum Austausch XML-Nachrichten anhand TCP/IP…

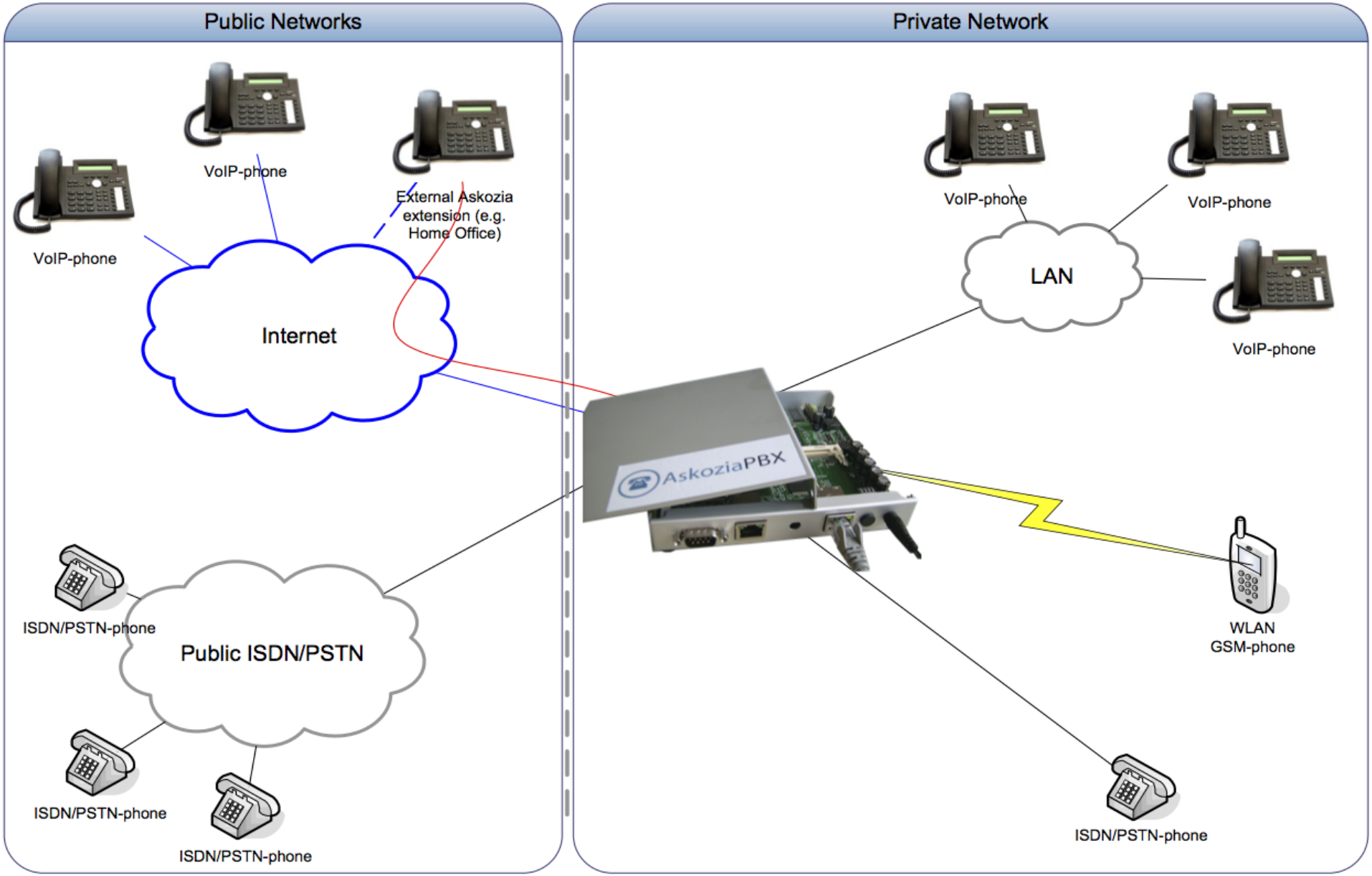


	I4a
	HTTPS / HTML
	TCP/UDP, TLS
	IP

	I3a	I3b	I3c	I3d
7				
6				
5				
4	TCP/UDP?, TLS	TCP/UDP?, TLS	TCP/UDP?, TLS	TCP/UDP?, TLS
3	IP?	IP?	IP?	IP?
2				
1	GSM/GRPS/UMTS/LTE	HFC (Hybrid Fibre Coax)	PLC	xDSL

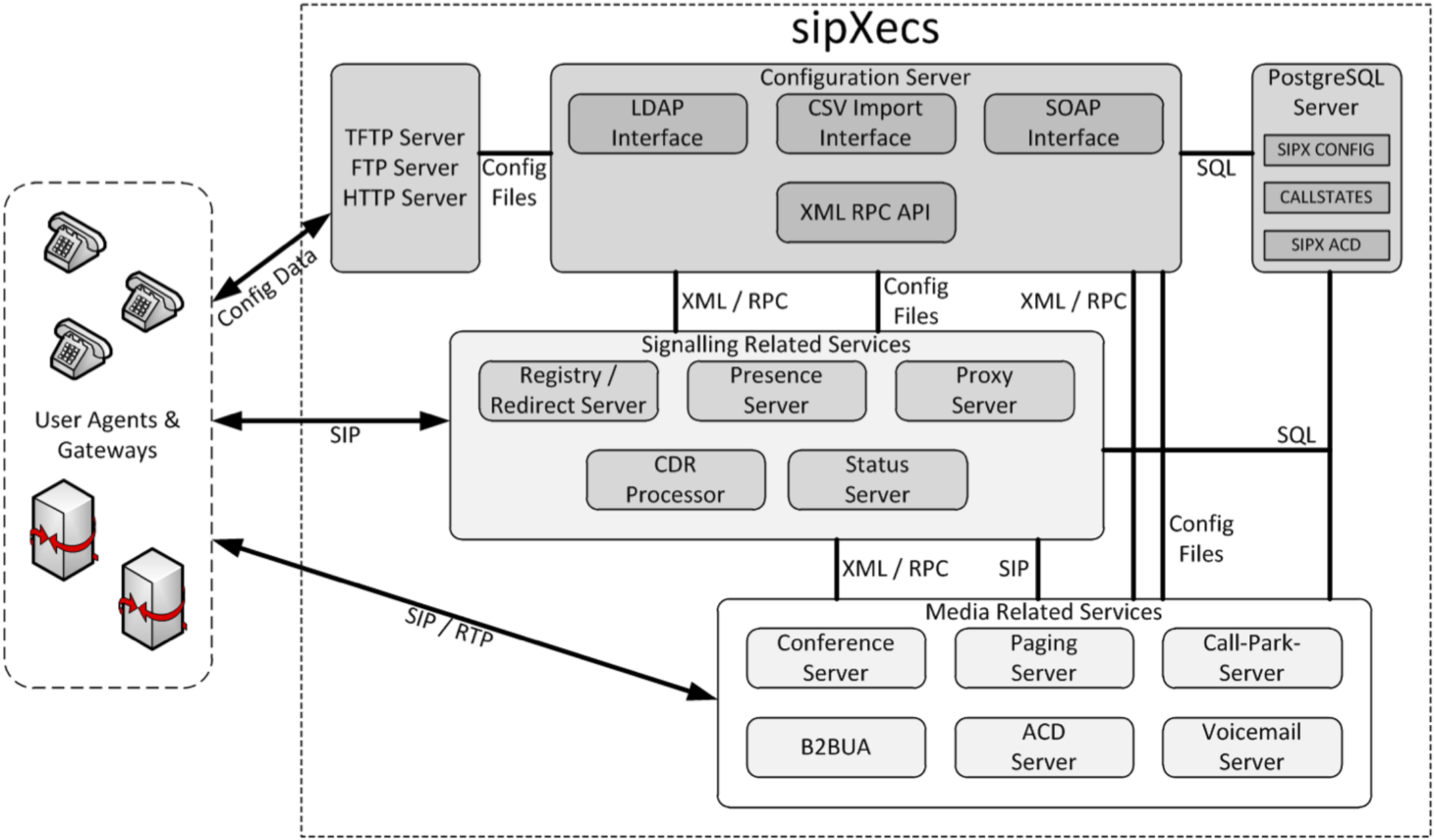
	I2a	I2b	I2c
7		HTTPS / HTML	SIP
6			
5			
4	TLS	TCP/UDP, TLS	TCP/UDP, TLS
3		IP	IP
2			
1			

	I1a	I1b	I1c	I1d	I1e
7	SML (Smart Message Language)	M-Bus	OSGP with ANSI C 12 structure	OMS (Open Metering System)	SIP (Session Initiation Protocol)
6					
5					
4	TCP/UDP, TLS			TLS	TCP/UDP, TLS
3	IP / IP-Telemetry	M-Bus	EN 14908-1	IP?, IP-Telemetry	IP / IP-Telemetry
2	Ethernet (CSMA/CD)	M-Bus		Lo-Bus, RS 485	Ethernet (CSMA/CD)
1		M-Bus	PLC		
	SyM²-Consortium	EN-13757-4	ECHELON	OMS-Group	SIP-Forum



Hybride VoIP-Anlage als monolithische Software

(Asterisk-basierte VoIP PBX)



Enterprise Unified Communications as Distributed System:

SIP Service Oriented Architecture (SSOA)

LTE-EPC AND IMS REFERENCE 23.228

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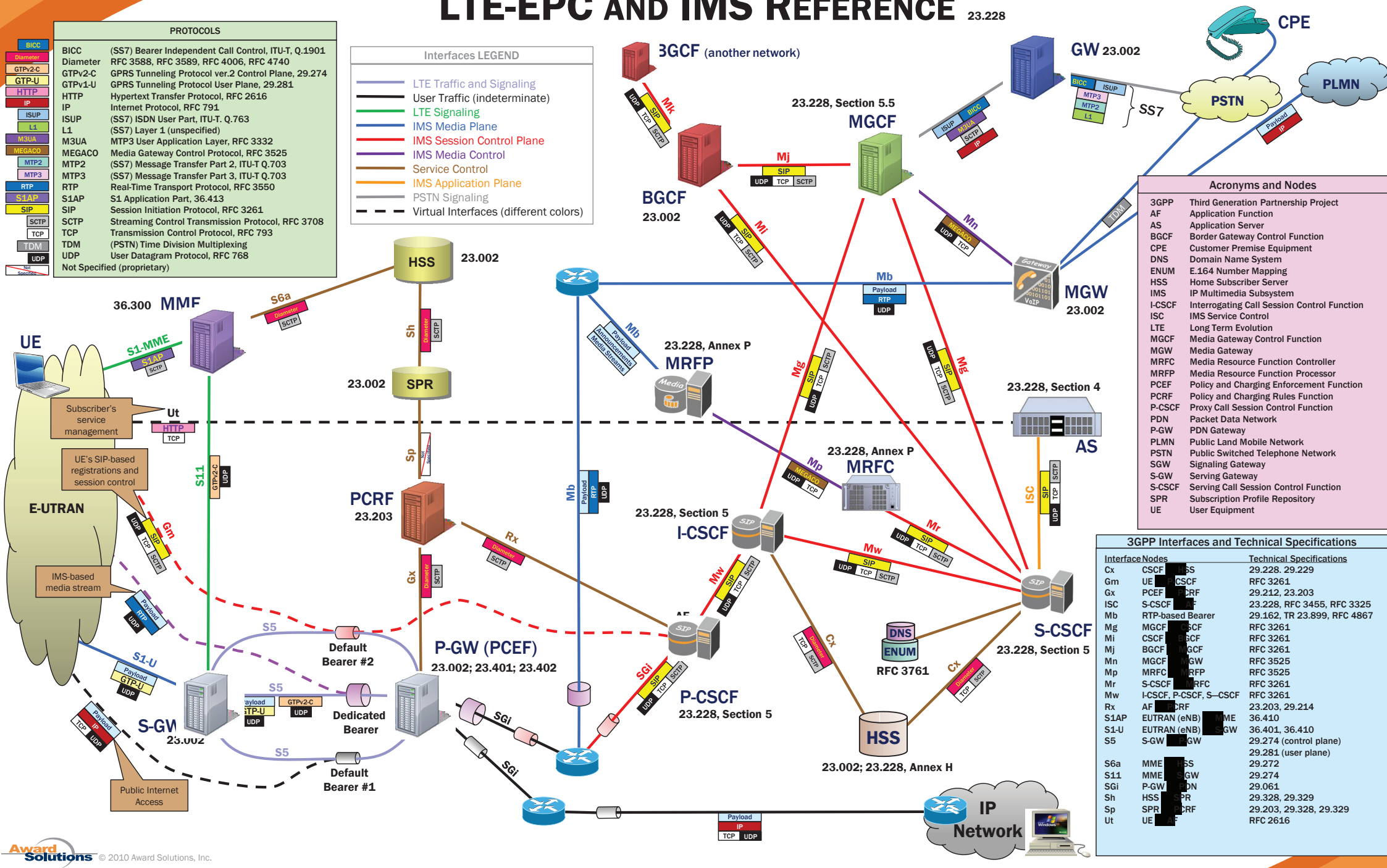

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Mn	MGCF – MGW	RFC 3525
Mp	MRFC – MRFP	RFC 3525
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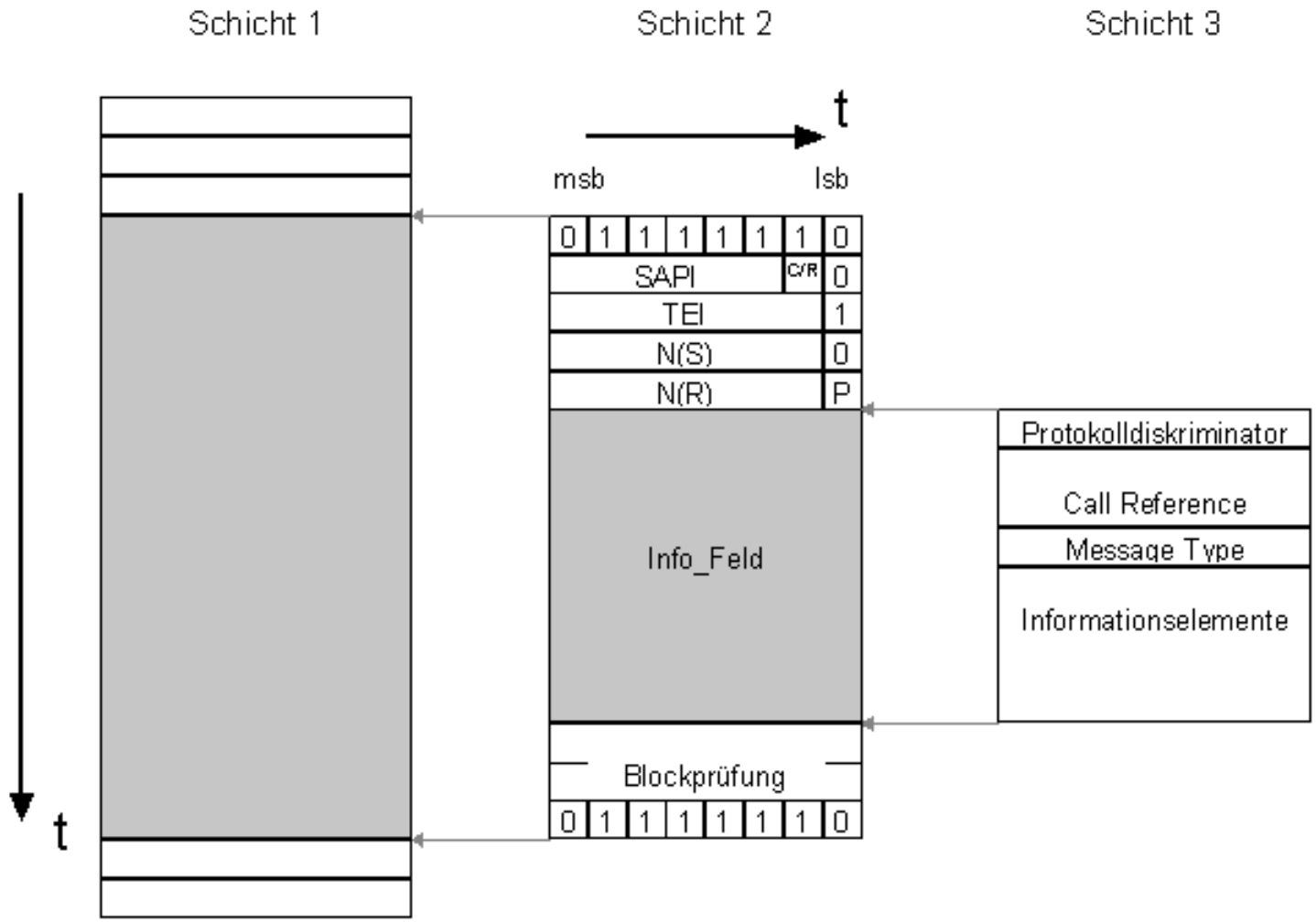
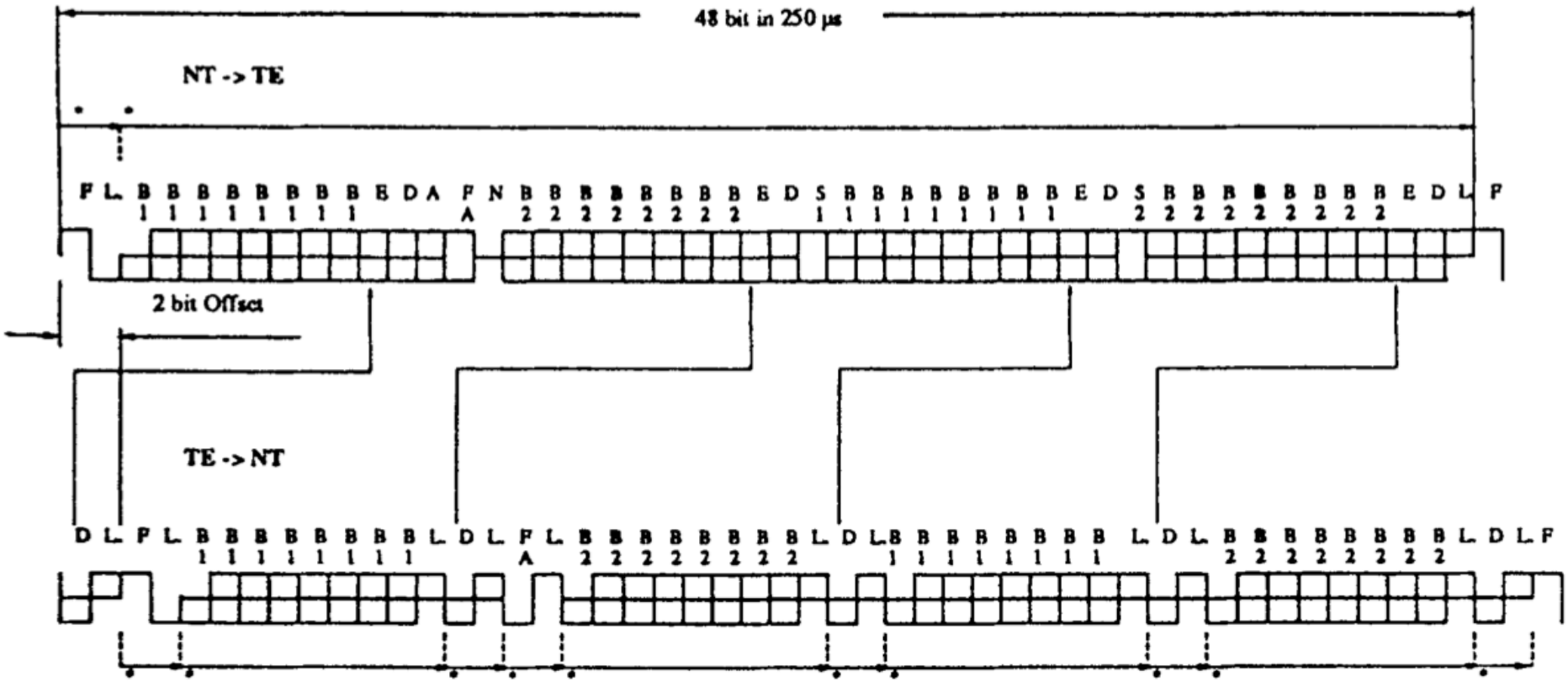
Sp	SPR – PCRF	29.203, 29.328, 29.329
Ut	UE – AF	RFC 2616



Example for a Coded Protocol (ISDN D-Channel Frame)



F: Rahmenbit
L: L-Bit (DC-Balance-Bit)
D: D-Kanalbit
E: D-Echokanalbit (nur NT -> TE)

N: N-Bit, als binäre '1' festgelegt

B1: Bit im B1-Kanal
B2: Bit im B2-Kanal
S1, S2 : Füllbits, als binäre '0' festgelegt
A: Aktiviertbit (binär '1' nach Aktivierung, nur Richtung NT -> TE
F_A: zusätzliches Rahmenbit (binär '0', in beiden Richtungen)

Anmerk.: Pfeile, die mit einem ' * ' gekennzeichnet sind, markieren Bereiche, die in sich gleichstromfrei sind.

Example for a Coded Protocol (ISDN D-Channel Layer 1)

Nachrichten bei Verbindungen mit B-Kanalbenutzung									
Nachrichtenkategorie	Bit-Nummer								Nachrichtenname und Message Type
	8	7	6	5	4	3	2	1	
Nachrichten für den Verbindungsaufbau/abbau	0	0	0	0	0	0	0	1	ALERTing
	0	0	0	0	0	0	1	0	CALL SENT
	0	0	0	0	0	1	1	1	CONNect
	0	0	0	0	1	1	1	1	CONNect ACKnowledge
	0	1	0	0	0	0	0	0	DETach
	0	1	0	0	0	1	0	1	DISConnect
	0	1	0	0	1	1	0	1	RELease
	0	1	0	1	1	0	1	0	RELease ACKnowledge
	0	0	0	0	0	1	0	1	SETUP
	0	0	0	0	1	1	0	1	SETUP ACKnowledge
Nachricht für allgemeine Anwendungen	0	1	1	0	1	1	0	1	INFOrmation
Nachrichten für verbindungsabhängige Dienstmerkmale	0	1	1	0	0	0	0	0	FACility
	0	1	1	0	1	0	0	0	FACility ACKnowledge
	0	1	1	0	0	1	0	1	FACility REJect
Nachrichten für Endgeräteportabilität	0	0	1	0	0	1	1	0	RESume
	0	0	1	0	1	1	1	0	RESume ACKnowledge
	0	0	1	0	0	0	1	0	RESume REJect
	0	0	1	0	0	1	0	1	SUSPend
	0	0	1	0	1	1	0	1	SUSPend ACKnowledge
	0	0	1	0	0	0	0	1	SUSPend REJect
Nachricht für Zustandsanzeige	0	1	1	0	0	0	1	1	STATus

Example for a Coded Protocol (ISDN D-Channel Layer 3)

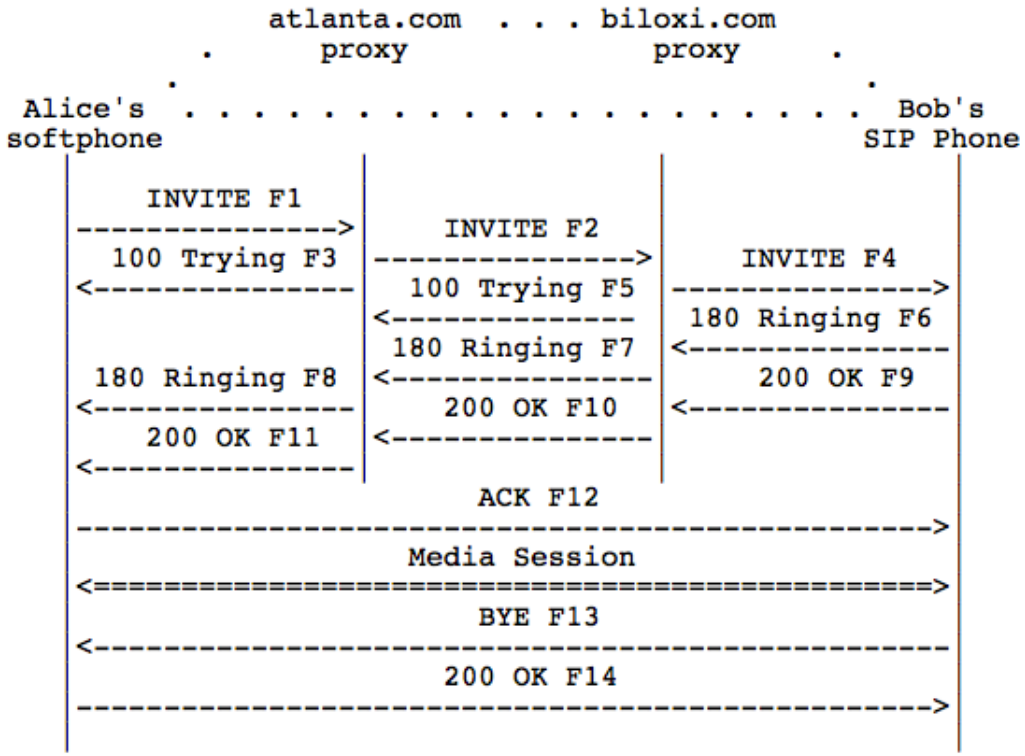
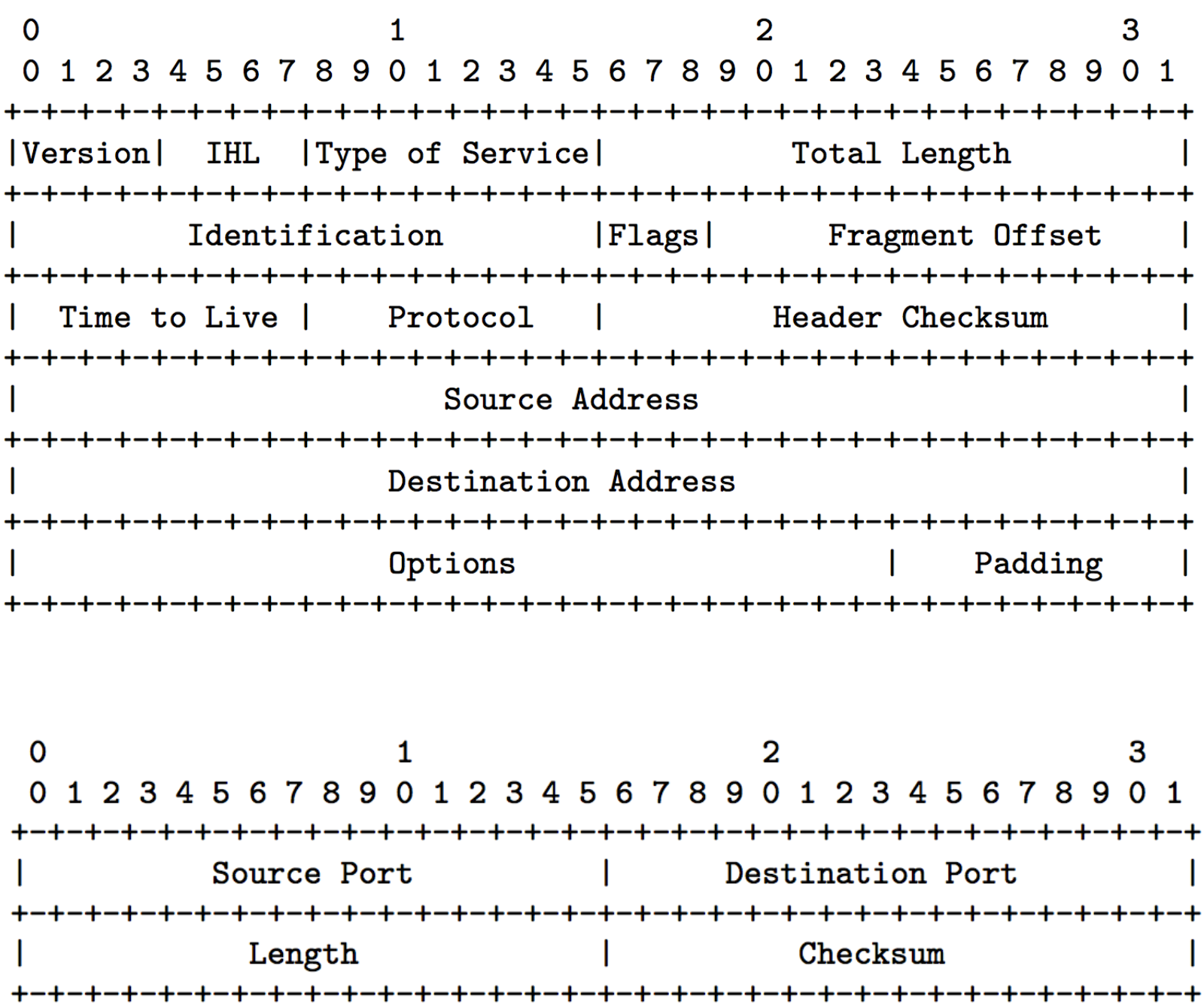


Figure 1: SIP session setup example with SIP trapezoid

```
INVITE sip:bob@biloxi.com SIP/2.0
Via: SIP/2.0/UDP pc33.atlanta.com;branch=z9hG4bK776asdhds
Max-Forwards: 70
To: Bob <sip:bob@biloxi.com>
From: Alice <sip:alice@atlanta.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.com
CSeq: 314159 INVITE
Contact: <sip:alice@pc33.atlanta.com>
Content-Type: application/sdp
Content-Length: 142

(Alice's SDP not shown)
```

The first line of the text-encoded message contains the method name (INVITE). The lines that follow are a list of header fields. This example contains a minimum required set. The header fields are briefly described below:



IPv4 Header (top), UDP Header (bottom)

Example of a Clear Text Protocol

(SIP-message INVITE (Header))

```
Session Initiation Protocol
   Request-Line: INVITE sip:602@141.41.40.232 SIP/2.0
      Method: INVITE
   Message Header
      Via: SIP/2.0/UDP 141.41.40.138:22302;branch=z9hG4bK-d87543-f9dcad167a9a2f49-1--d87543-;rport
         Transport: UDP
         Sent-by Address: 141.41.40.138
         Sent-by port: 22302
               ...
      Max-Forwards: 70
      Contact: <sip:604@141.41.40.138:22302>
         Contact Binding: <sip:604@141.41.40.138:22302>
            URI: <sip:604@141.41.40.138:22302>
               SIP contact address: sip:604@141.41.40.138:22302
      To: "602"<sip:602@141.41.40.232>
         SIP Display info: "602"
         SIP to address: sip:602@141.41.40.232
      From: "Matthias Bormann"<sip:604@141.41.40.232>;tag=bd858435
         SIP Display info: "Matthias Bormann"
         SIP from address: sip:604@141.41.40.232
         SIP tag: bd858435
      Call-ID: ZWVlNTg2Y2NiOTY3Zjk3NjU4YTUwNzEwZGY0OTRlMWY.
      CSeq: 2 INVITE
         Sequence Number: 2
         Method: INVITE
      Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY, MESSAGE, SUBSCRIBE, INFO
      Content-Type: application/sdp
      Proxy-Authorization: ...
               ...

      Content-Length: 956
   Message body
      Session Description Protocol
         Session Description Protocol Version (v): 0
         ...
```

Example of a Clear Text Protocol

(SIP-message INVITE (Body))

```
Message body
   Session Description Protocol
      Session Description Protocol Version (v): 0
      ...
      Session Name (s): CounterPath eyeBeam 1.5
      Connection Information (c): IN IP4 141.41.40.138
         Connection Network Type: IN
         Connection Address Type: IP4
         Connection Address: 141.41.40.138
      ...
      Media Description, name and address (m): audio 32302 RTP/AVP 100 106 6 0 105 8 18 3 5 101
         Media Type: audio
         Media Port: 32302
         Media Proto: RTP/AVP
         Media Format: 100
         Media Format: 106
         Media Format: DVI4 16000 samples/s
         Media Format: ITU-T G.711 PCMU
         Media Format: 105
         Media Format: ITU-T G.711 PCMA
         Media Format: ITU-T G.729
         Media Format: GSM 06.10
         Media Format: DVI4 8000 samples/s
         Media Format: 101
      Media Attribute (a): x-rtp-session-id:66B390675BD11CE72803067C7F7AD21F
      ...
      Media Description, name and address (m): video 27874 RTP/AVP 125 126 115 34
         Media Type: video
         Media Port: 27874
         Media Proto: RTP/AVP
         Media Format: 125
         Media Format: 126
         Media Format: 115
         Media Format: ITU-T H.263
      Media Attribute (a): x-rtp-session-id:06AE29EEA3B40D41D0BF9A6E39506C4D
         Media Attribute Fieldname: x-rtp-session-id
         Media Attribute Value: 06AE29EEA3B40D41D0BF9A6E39506C4D
```