

# *Wireless Standards: From 2G to 3G*

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# *Presentation Overview*

2G Standards

From 2G to 3G

3G Standardization

Wireless and the Internet

# *2G Standards*

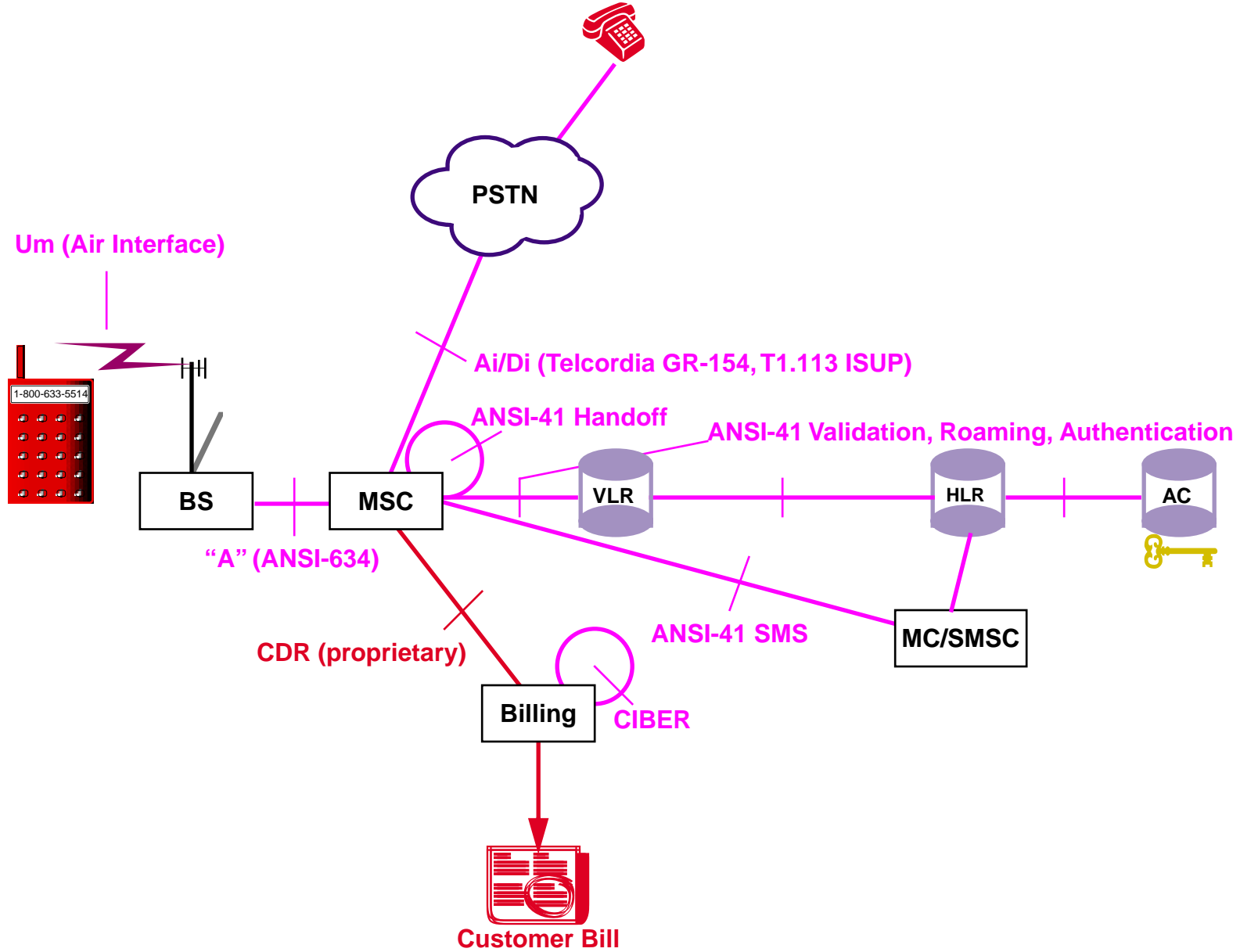
The 2G Network

Major Air Interface Standards

Mobile Application Parts

Transport Network

# Yesterday's 2G Network (TIA/EIA-41)



# Major Air Interface Standards Compared

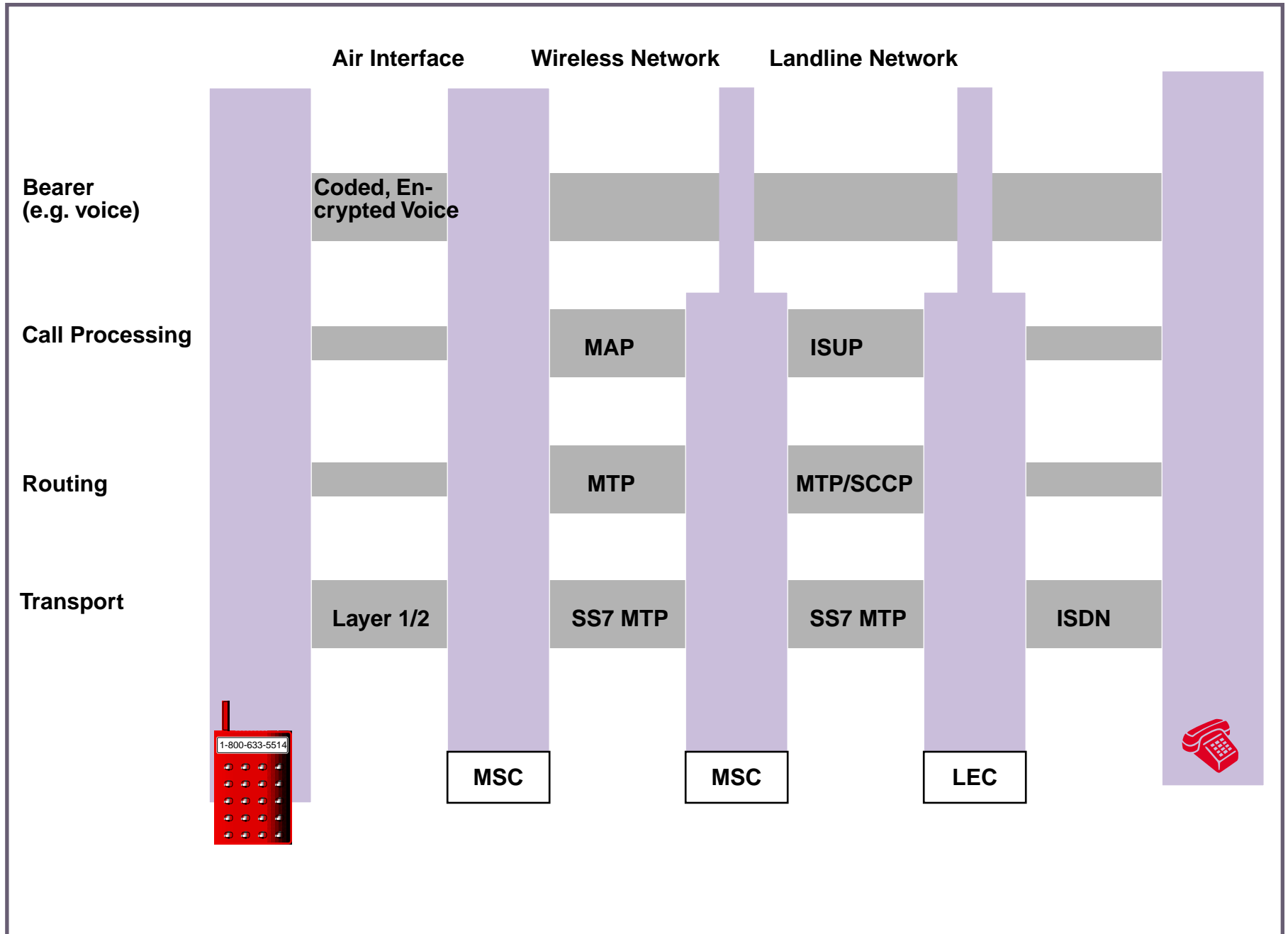
	AIR INTERFACE TECHNOLOGY					
	Analog		TDMA		CDMA	
	AMPS	NAMPS	GSM	D-AMPS	13 kbps Vocoder	8 kbps Vocoder
<b>Parameter</b>	EIA/ TIA-553	IS-88, IS-91	TS GSM	IS-54, IS-136	IS-95, IS-2000	
<b>A: Available Spectrum</b>	12,500 kHz (amount allocated for US cellular, used as a base for comparison purposes)					
<b>B: RF channel bandwidth (kHz)</b>	30	10	200	30	1389	1389
<b>T: Number of traffic channels per RF channel</b>	1	1	8	3	13	18
<b>R: Reuse Factor</b>	24	28	18	36	1	1
<b>V: Number of Traffic channels per sector ( (A ÷ B) × (T ÷ R) )</b>	17.4	44.6	27.8	34.7	117	162
<b>E: Erlangs / sector</b>	9.9	33.6	18.5	24.5	101	144
<b>Capacity relative to “standard” AMPS</b>	<b>0.8</b>	<b>2.6</b>	<b>1.4</b>	<b>1.9</b>	<b>7.9</b>	<b>11.3</b>

Source: Drucker Associates (e.drucker@verizon.net)

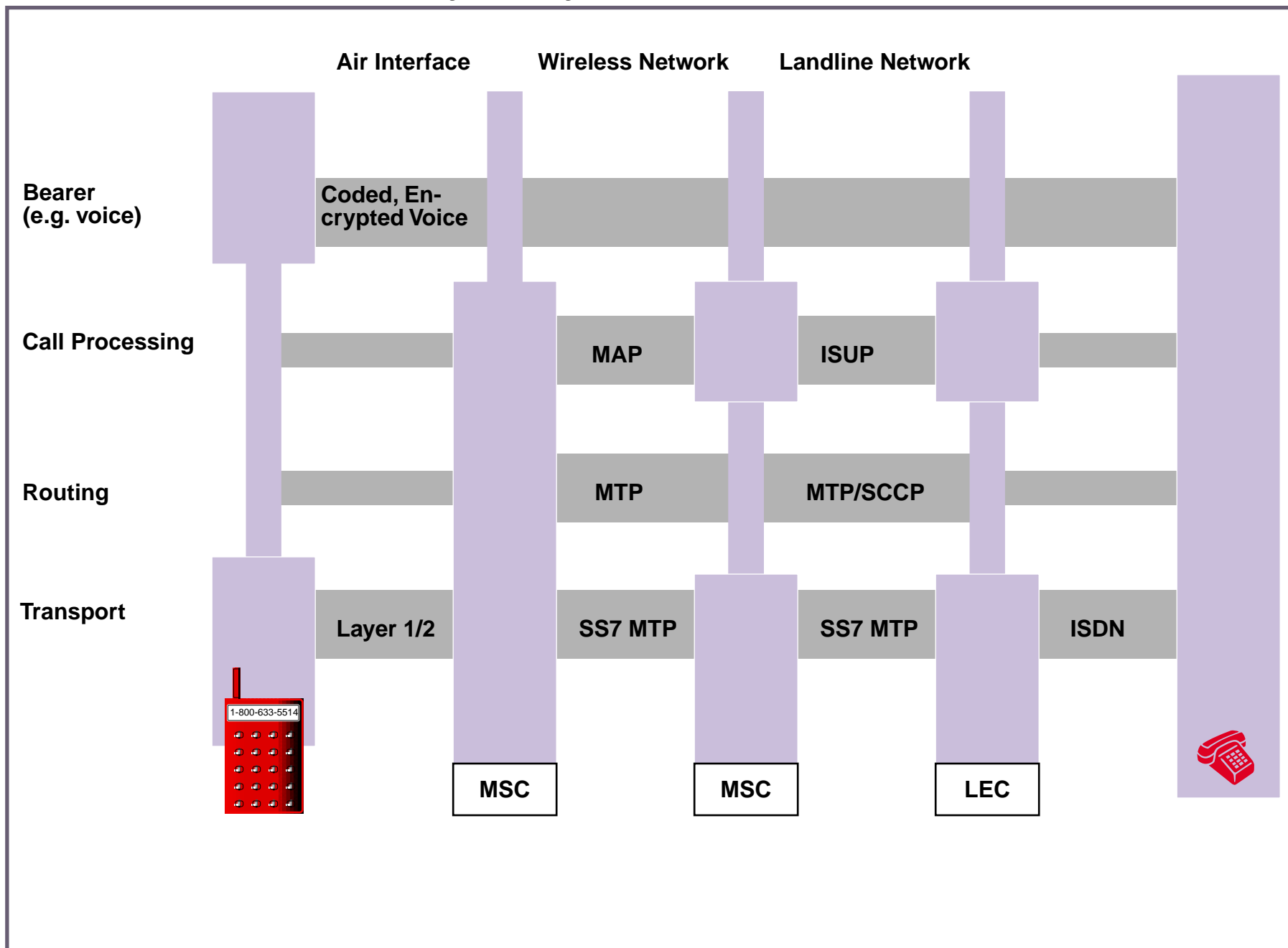
# *2G Air Interface Limitations*

- Oriented toward voice services
- Compatibility between technologies was not a high priority
- Inadequate layering
- Low bit rates provided (8-30 kbps)
- Protocol Parochialism

# The Way Layers Are...



# *The Way Layers Should be...*





# *Mobile Application Part (MAP)*

- Real-time connectivity between network equipment made by different vendors and used by different carriers.
- Extends wireless capabilities, such as handoff and call delivery to a network.
- GSM MAP supports GSM cellular and PCS systems
- TIA/EIA-41 (aka IS-41 or ANSI-41) supports AMPS, NAMPS, D-AMPS/TDMA and CDMA (cdmaOne and cdma2000) systems.
- Other cellular systems (e.g. TACS, NMT) do not support wide area roaming.

# *MAP Limitations*

- No compatibility between TIA/EIA-41 and GSM MAP at any protocol layer.
- Designed around limitations of SS7.
- Ensuring compatibility with older, operational revisions makes integration of new features very difficult.

# *Transport Network*

- Provides Connectivity between Wireless Network Elements
- X.25 was first used for IS-41 systems, but has poor packet-switching capabilities.
- SS7 is used for most TIA/EIA-41 and GSM MAP networks.
- ANSI SS7 used in US and Canada over T1 trunks
- Other countries use variants of ITU SS7 (CCS7) over E1 trunks

## *Limitations of SS7*

- Low speed (56-64 kbps)
- Limited payload size (200-250 bytes) without segmentation
- Basic addressing (point codes) is national
- International gateways required for international SS7 routing
- Global title addressing is international, but only through complex conversions
- Global title addressing is a maintenance nightmare
- Forward compatibility is almost impossible, restricting use of global titles, high speed links, message segmentation and larger messages

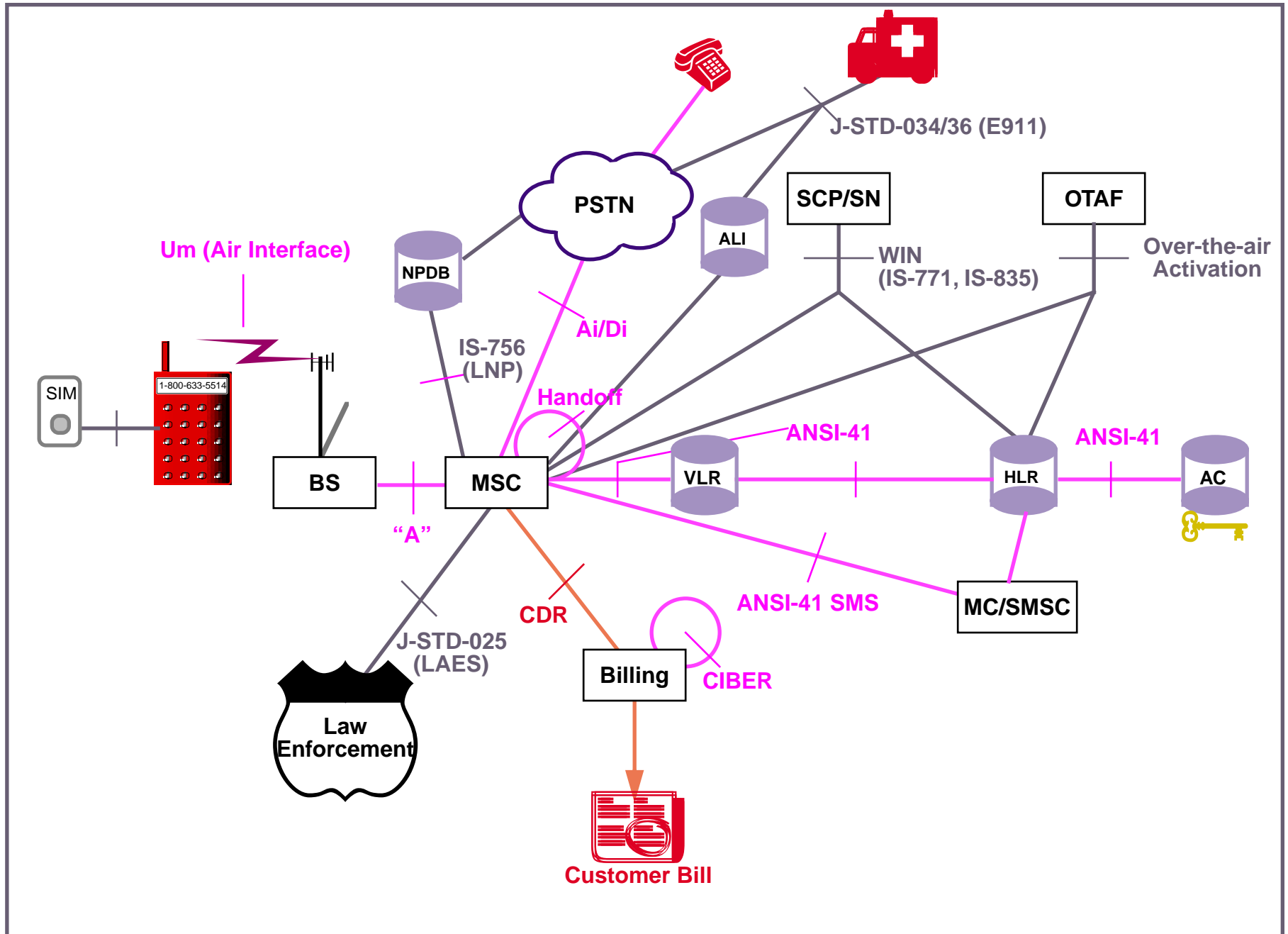
# *From 2G to 3G*

Today's 2.5G Network

Government Mandates

New Capabilities and Services

# Today's 2.5G Network (TIA/EIA-41)



# *US Government Mandates*

US Government mandates must be accommodated in current 3G systems, and in other countries if and when they are adopted:

- CALEA - lawfully authorized electronic surveillance (“wireless wiretap”)
- LNP - porting numbers between carriers, both wireless and landline
- E911 - providing callback number, cellsite identity and position to emergency call takers
- PAS - gives emergency workers higher priority when systems are blocked

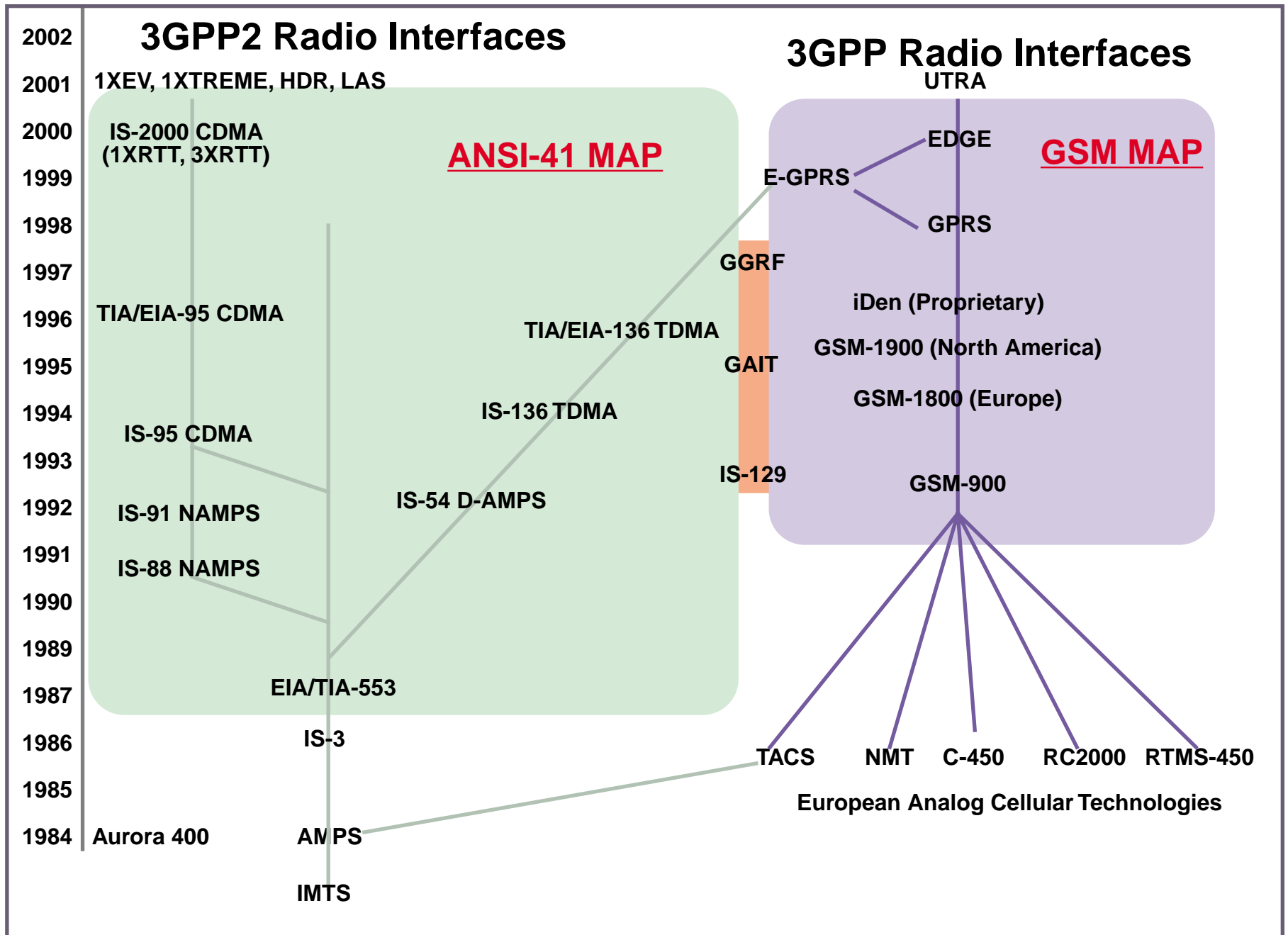
# *New Capabilities and Services*

*Some 2.5G capabilities must be brought forward into 3G:*

- Over-the-air programming
- Circuit Switched Data
- Mobile originated and broadcast SMS
- Multi-band operation
- International capabilities
- Wireless Intelligent Network



# Evolution of Cellular Radio Interfaces



# *3G Systems*

3G Requirements

The 3G Network

3G Partnership Project (3GPP)

3G Partnership Project 2 (3GPP2)

# *3G Requirements*

Focus on high speed data

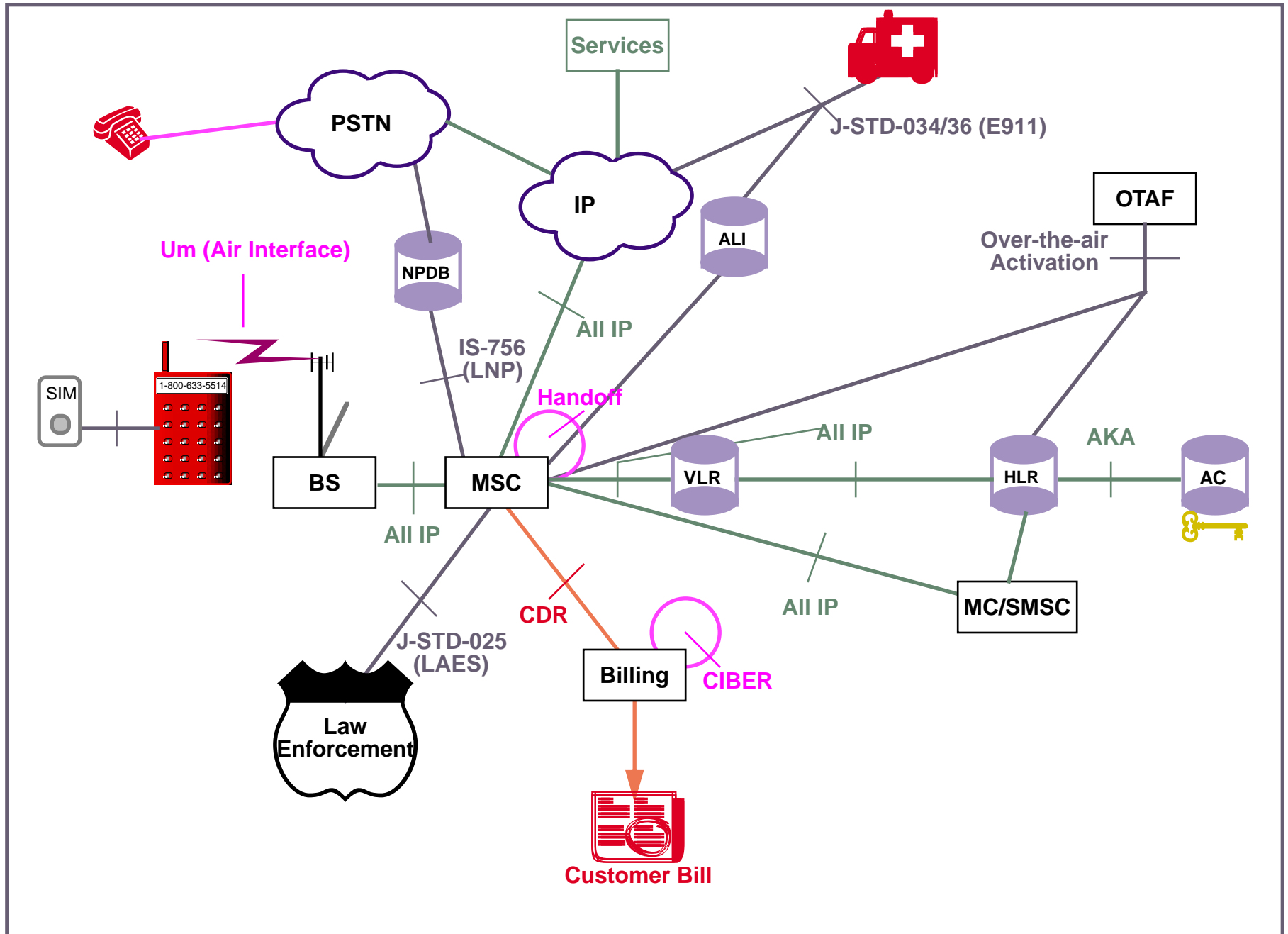
Environment	Terminal Speed	Bit rate
Rural	$\leq 250$ km/hr (Freeway, Train)	144-384 kbps
Urban/Suburban	$\leq 150$ km/hr (Car, Bus)	384-512 kbps
Indoor/Campus	$\leq 10$ km/hr (Pedestrian)	up to 2 Mbps

# *A Bit of a Conundrum*

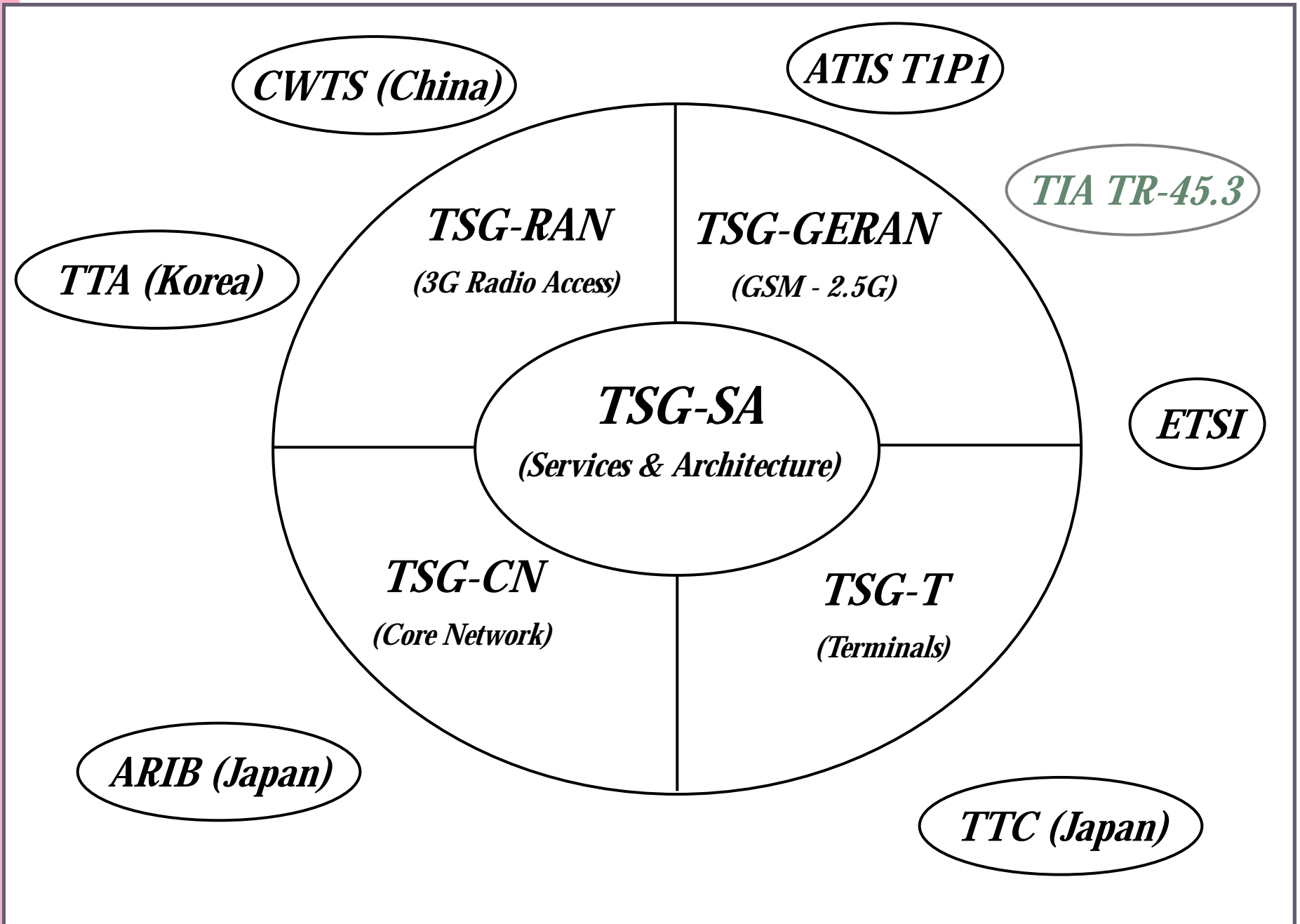
Can Carriers afford Wireless Data?

	Past	Present	Future
Voice Coder	n/a	8-13 kbps	4-8 kbps
User Data	9.6-14.4 kbps	14.4-64 kbps	64kbps-2Mbps
Expectations			
Ratio	$\approx 1x$	$\approx 1x$	8-500x

# 3G Network



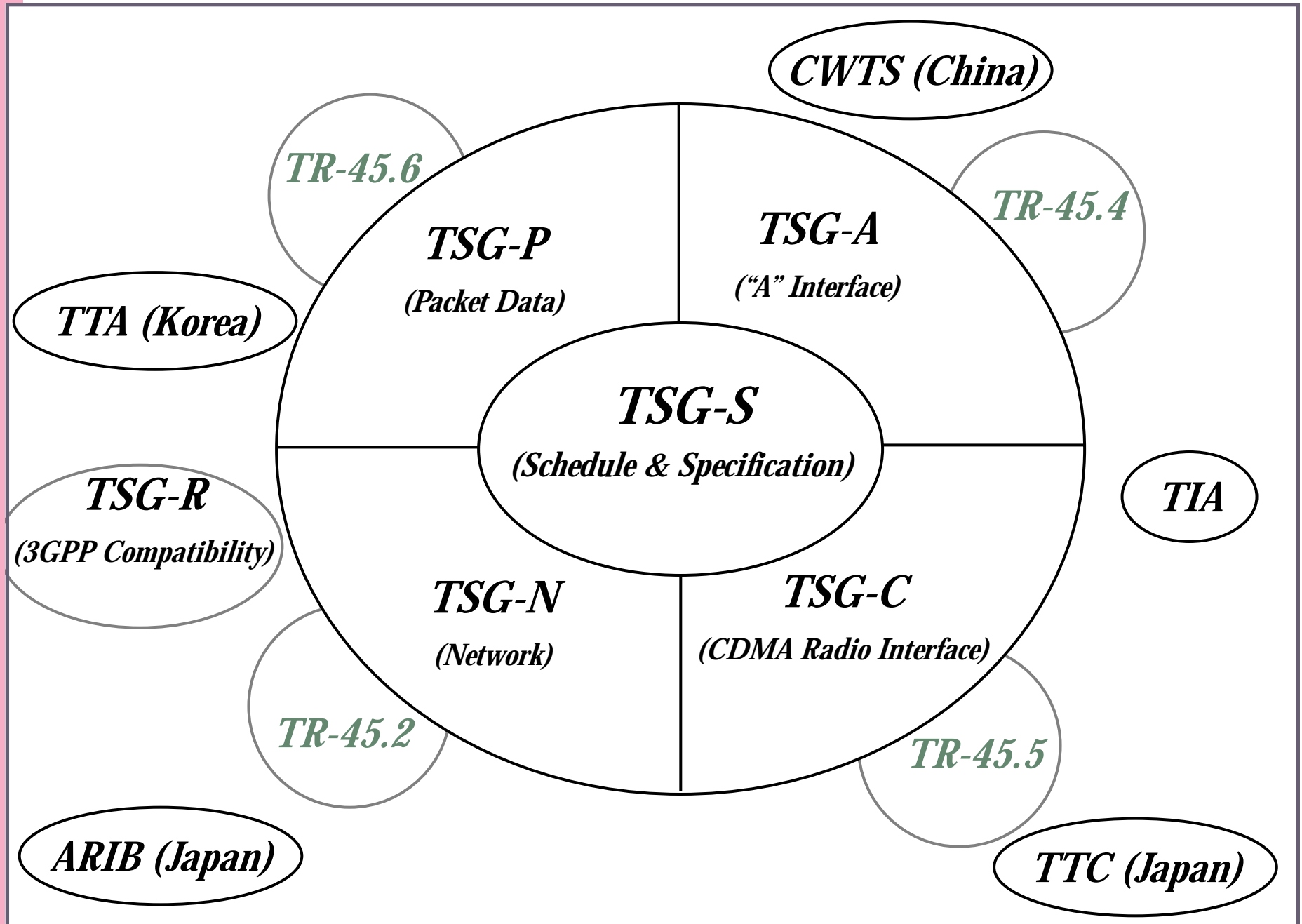
# 3GPP Technical Specification Groups (TSGs)



# *3GPP Radio Interface Standards*

Technology	Description	Speeds (kbps)
HSCSD	Software upgrade to GSM	57.6
	EDGE/GPRS/EGPRS	
EDGE Compact	Enhanced modulation in 3 200 kHz channels	24-70
EDGE Classic	Enhanced modulation (QAM/GMSK) in 12 200 kHz channel	100-170
W-CDMA/ UTRA	Wideband CDMA (4.096 Mcps)	2,000

# 3GPP2 Technical Specification Groups (TSGs)





## *3GPP2 Radio Interfaces*

<b>Technology</b>	<b>Description</b>	<b>Data Speed</b>
TIA/EIA-95-B	Channel aggregation (up to 8)	64-115 kbps
1XRTT (IS-2000, cdma2000)	Enhanced modulation (TIA/EIA-95-B)	144 kbps
3XRTT	3 x 1.25 MHz carriers	≤ 1 Mbps
	1xEV-DO (High speed, data only)	
HDR	IS-856 (Qualcomm)	2.4 Mbps
	1xEV-DV (High speed data, and voice)	
1XTREME	Nokia/Motorola	5 Mbps
LAS	LinkAir Chinese/US proposal	n/a
SAPHIRE	Samsung proposal	n/a
n/a	Lucent proposal	n/a

# *Authentication: Working Together*

Authentication uses a challenge (random number)/response method to determine whether a mobile is who it say it is. Currently, GSM and ANSI-41 use incompatible methods

- GSM: Challenge/Response provided by home system in 'triplets'. Serving system is unaware of the algorithm used.
- ANSI-41: Challenge/Response calculated by serving system from secondary keys provided by home system.
- AKA: Challenge/Responses provided by home system in 'quintuplets'. These can be used to calculate local keys to be used for local authentication.

3GPP and 3GPP2 have both accepted AKA!

# *Wireless & Internet Convergence or Collision?*

## Wireless Telecom

Crew Cut

Right of Stockwell

Keep it

If it ain't broke...

Patriotism

Never Fail

Dividends

Compatibility

## Internet

Ponytail

Left of Lenin

Change it

Go for broke...

Anarchy

Reboot

IPO

Upgrade required

# *Wireless Internet Opportunities*

- Applications (imode, WAP, HDML, WML, etc.)
- Signaling
  - No Boundaries (Global)
  - Higher Speeds
  - Cheaper Equipment
- Packet Voice
- Reduction of Voice Decoding/Recoding
- Voice/Data Integration
- Coolness Quotient

## *About the Author*

David Crowe is the writer and publisher of *Cellular Networking Perspectives*, and publisher of *Wireless Security Perspectives*. He writes regular columns and feature articles for Intertec's *Wireless Review* magazine and CWTA's *Wireless Telecom*. He chairs TIA subcommittee TR-45.2 Working Group VI on International applications of cellular standards, and is editor of Wireless-PSTN interconnection (TIA/EIA-93) and Emergency Services (J-STD-036) standards. His company has provided wireless standards consulting for major industry players, including ADC, Alcatel, Aeris, Agilent and AT&T Wireless...and that's just the A's! *Cellular Networking Perspectives Ltd.* also acts as the International Roaming MIN (IRM) administrator on behalf of ATIS/IFAST. David has been involved with wireless systems development since 1984 and wireless standards since 1988.



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