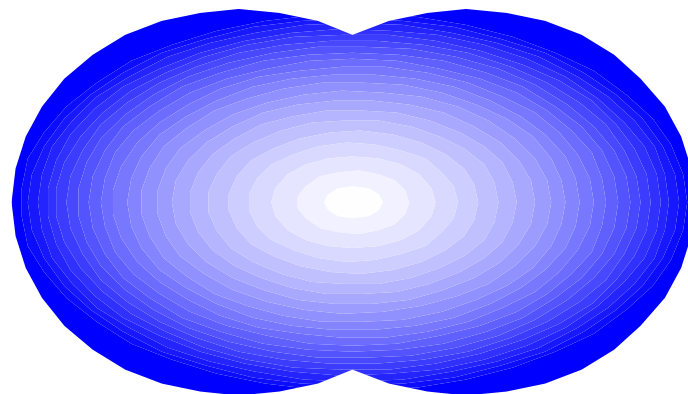
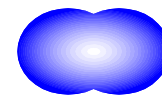


شاهین ارتباط تهران

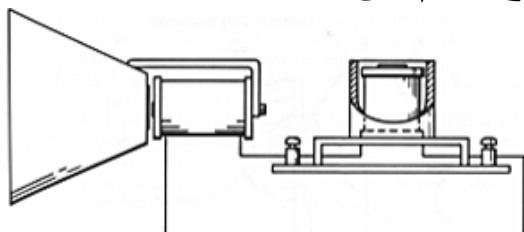


شرکت مهندسی مشاور
شاهین ارتباط تهران



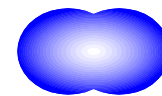
اختراع تلفن و شکل گیری شبکه تلفن

• ۱۸۷۶ میلادی: معرفی تلفن توسط گراهام بل



ویژگی ها

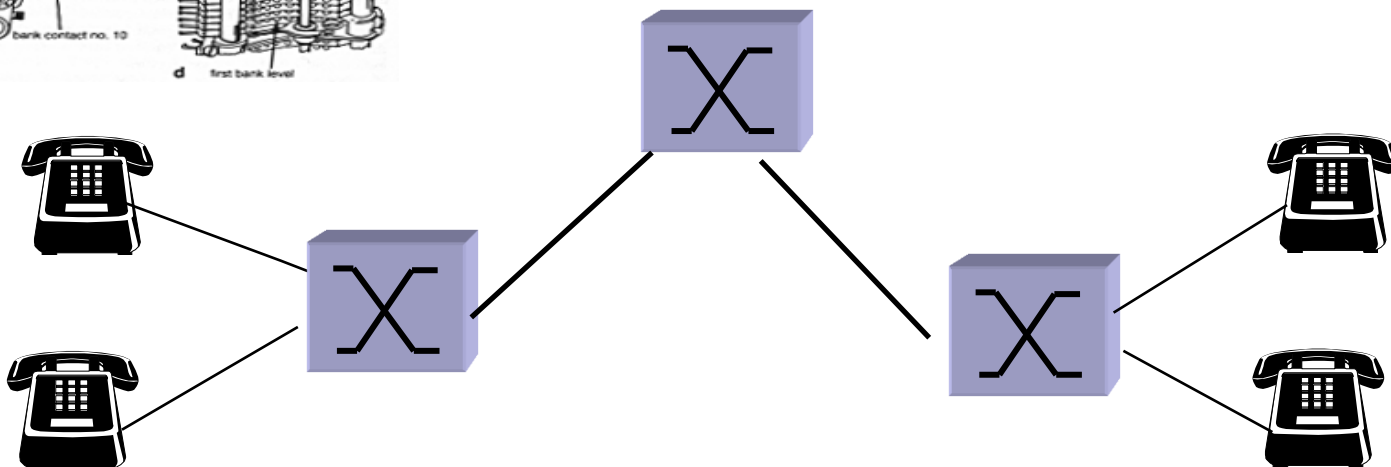
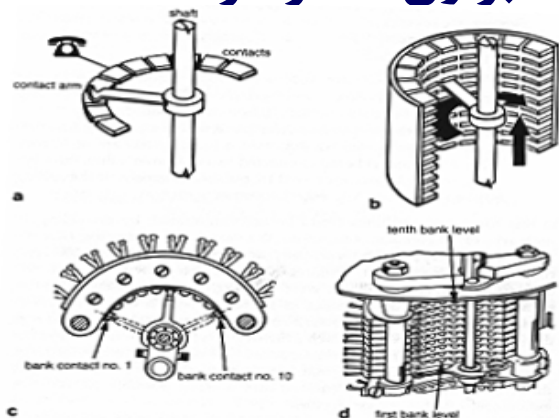
- تاخیر در برقراری مکالمه
- غیر قابل استفاده در شبکه های بزرگ

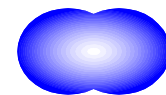


ظهور مراکز سوئیچ

• ۱۸۸۹ میلادی :

• اختراع سیستم سوئیچینگ مکانیکی توسط براون استراگر





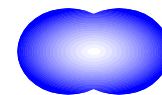
اختراع بی سیم موبایل (سیار)

چرا سیستم های بی سیم

– در هر مکانی

– در هر زمانی

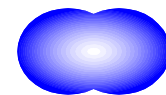
– تمام سرویس های مورد نظر در اختیار
مشترک قرار گیرد.



چگونگی ساختار شبکه بیسیم یا Mobile

باید به صورتی باشد که:

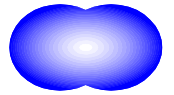
- ✓ در هر مکانی به مشترکین سرویس دهی شود
- ✓ با هر سرعتی مشترکین سرویس دهی شود
- ✓ مکان مشترکین مشخص شود
- ✓ هویت مشترکین مشخص شود
- ✓ سرویسی مورد درخواست مشترک یا مشترکین ارائه شود
- ✓ با تمام شبکه های دیگر ارتباط و تبادل داشته باشد



نسل های سیستم های سیار

- نسل اول (NMT , AMPS , TACS)
- نسل دوم (GSM900 , DCS1900 , PDC)
- نسل 2.5 (سیستم GPRS, EDGE و TETRA)
- نسل سوم (UMTS , IMT2000)
- نسل چهارم (ترکیب سیستم های Wi-MAX , WLAN , GSM به منظور ایجاد یک شبکه Board Band)

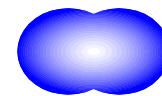
PMR



شاهین ارتباط تهران

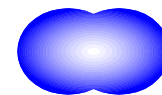
- PMR is the oldest form of mobile communications – it has been in use for over 70 years. It is used by many taxi and courier firms, security guards and utility companies. Many rural businesses choose the PMR option, because they find that they simply do not have mobile phone coverage, or they are in an area where the network frequently goes down.

مشکلات نسل اول First generation



شاهین ارتباط تهران

- استفاده از مدولاسیون آنالوگ
- محدودیت ظرفیت شبکه های مذکور
- عدم توانایی افزایش تعداد مشترکین
- تجهیزات با ابعاد فیزیکی بزرگ
- هزینه نگهداری بالا
- پایین بودن سطح امنیت
- عدم انطباق با شبکه های موبایل سایر کشورها (نداشتن سرویس رومینگ (Roaming)

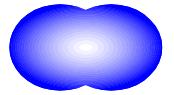


نسل اول (PMR)

- جهت بهبود در سیستم PMR یا Conventional سیستم ترانک ارائه گردید.
- سیستم PMR به دو حالت بودند:
- بیسیم های معمولی یا Conventional
- بیسیم های ترانک یا سلولی
- هر دو آنالوگ بودند

شبکه های سلولی

Cellular System

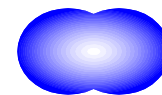


شاهین ارتباط تهران

- During the early 1980s
 - MPT1327 Analog cellular telephone systems were experiencing rapid growth in Europe (in Scandinavia, UK, France and Germany)
- In 1983
 - American (Advanced) Mobile Phone System (AMPS) developed in USA
- In 1985
 - Total Access Communication System (TACS) developed in UK
- In 1986
 - Nordic Mobile Telephony (NMT) 900 developed

مزیت شبکه های سلولی

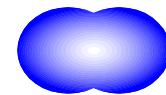
cellular network benefit



شاهین ارتباط تهران

- Group call
- Roaming
- Supports both semi-duplex and full duplex calls
- Average call duration is much shorter
- Calls can have multiple levels of priority
- Support data applications like AVL

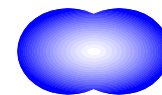
LIST of Analogue Cellular 2



شاهین ارتباط تهران

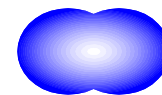
NMT900	Nordic Mobile Telephones/900. The 900 MHz upgrade to NMT 450 developed by the Nordic countries to accommodate higher capacities and handheld portables. Range 25km. Uses FDD FDMA technology.
NMT-F	French version of NMT900
NTT	Nippon Telegraph and Telephone. The old Japanese analogue standard. A high-capacity version is called HICAP.
RC2000	Radiocom 2000. French system launched November 1985
TACS	Total Access Communications System. Developed by Motorola. and is similar to AMPS. It was first used in the United Kingdom in 1985, although in Japan it is called JTAC. It operates in the 900 MHz frequency range.

LIST of Analogue Cellular 1



شاهین ارتباط تهران

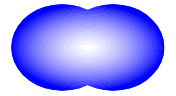
AMPS	Advanced Mobile Phone System. Developed by Bell Labs in the 1970s and first used commercially in the United States in 1983. It operates in the 800 MHz band and is currently the world's largest cellular standard.
C-450	Installed in South Africa during the 1980's. Uses 450Mhz band. Much like C-Netz. Now known as Motorphone and run by Vodacom SA.
C-Netz	Older cellular technology found mainly in Germany and Austria. Uses 450 MHz.
Comvik	Launched in Sweden in August 1981 by the Comvik network.
N-AMPS	Narrowband Advanced Mobile Phone System. Developed by Motorola as an interim technology between analogue and digital. It has some three times greater capacity than AMPS and operates in the 800 MHz range.
NMT450	Nordic Mobile Telephones/450. Developed specially by Ericsson and Nokia to service the rugged terrain that characterises the Nordic countries. Range 25km. Operates at 450 MHz. Uses FDD FDMA.



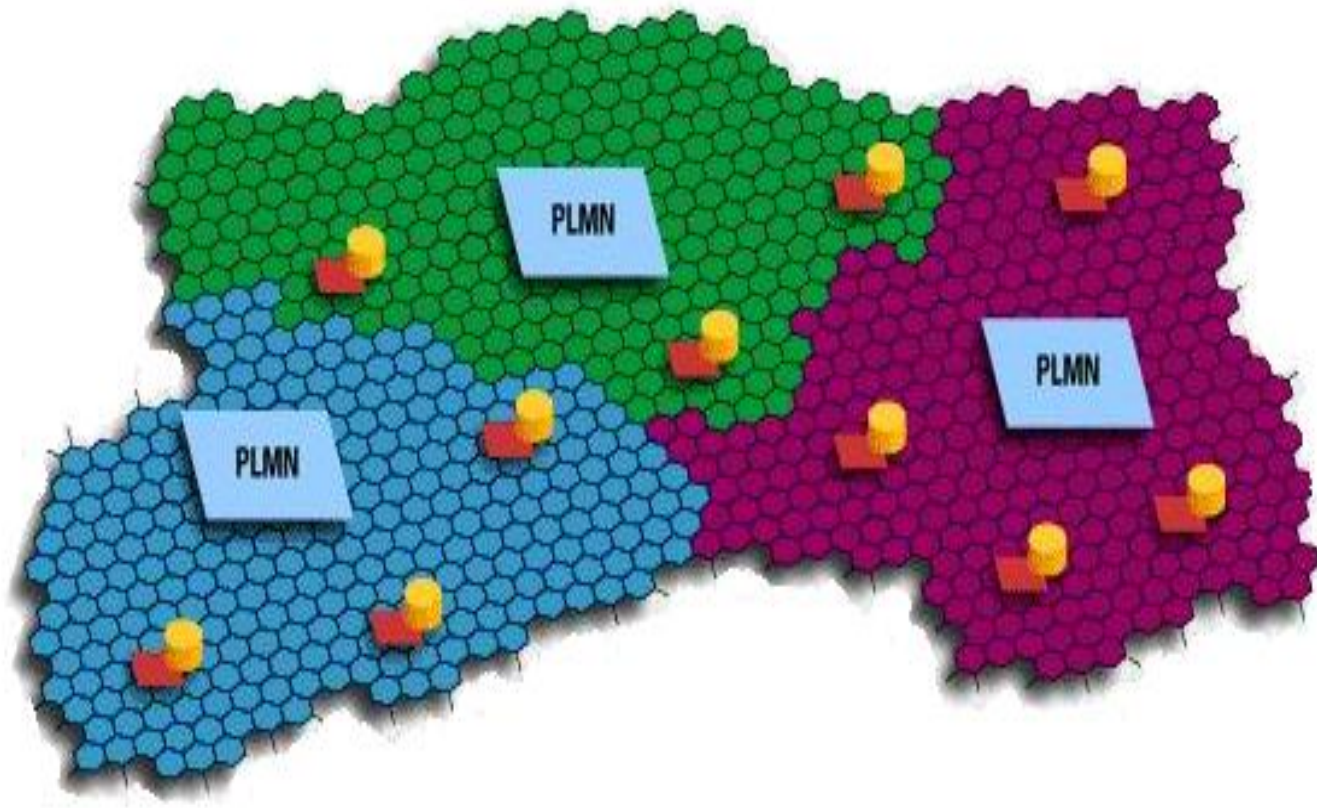
مشکلات سیستم های سلولی اولیه

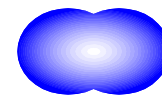
- کشورهای مختلف با سیستم ویژه هر کشور
وعدم تطابق این سیستمها با هم
- نیاز به یک سیستم با استاندارد واحد

Cellular Concept

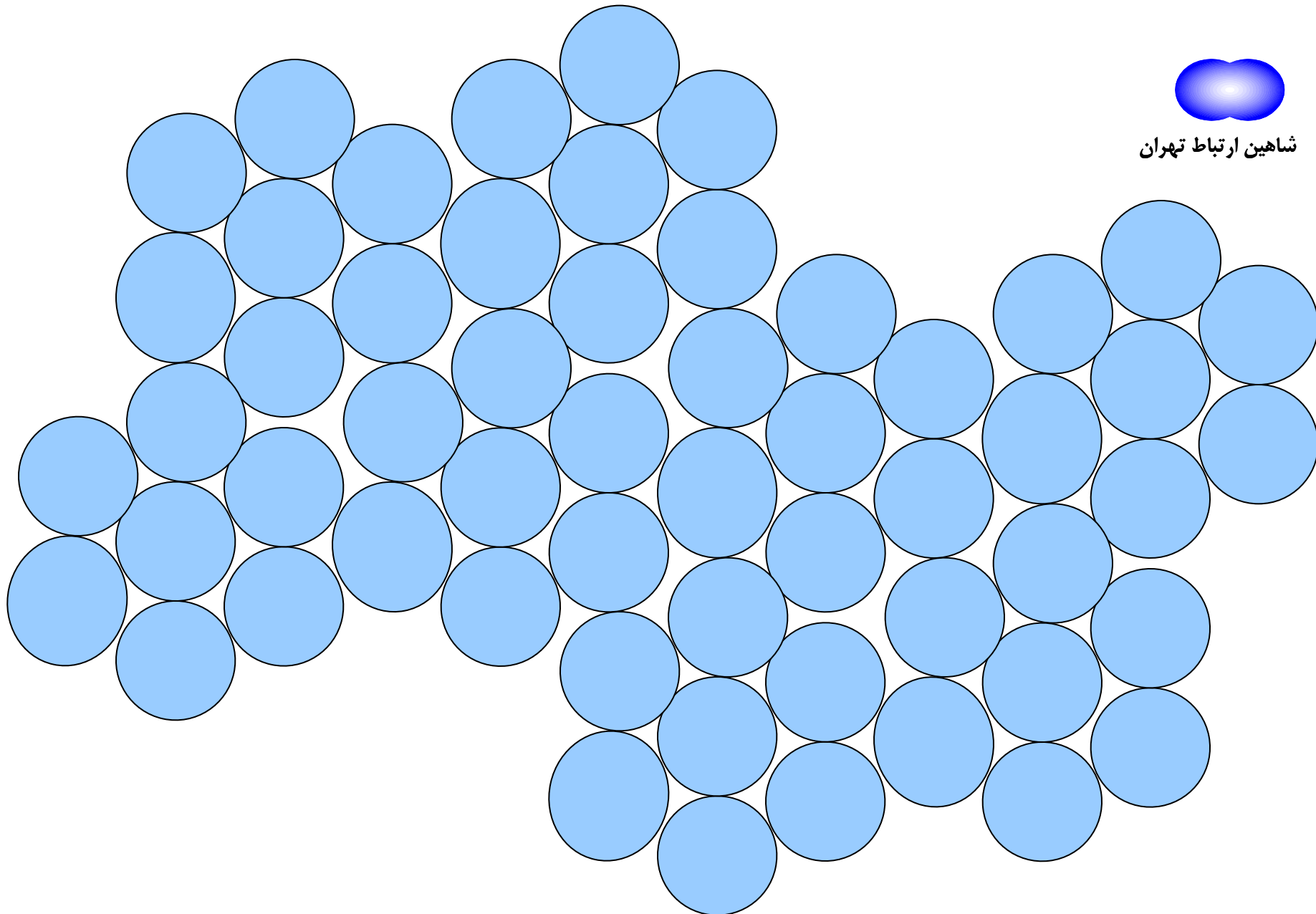


شاهین ارتباط تهران

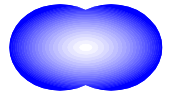




شاهین ارتباط تهران



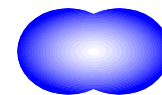
Trunking Definition



شاهین ارتباط تهران

A **trunked radio system** is a radio system used to maximize available capacity in a two-way radio system, usually UHF.

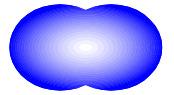
Groups of users are given a logical talkgroup to share for their communications, rather than a dedicated radio frequency.



Trunking techniques

Trunking techniques have been used for many years in switched telephone networks. The first trunked mobile radio communication systems were deployed as early the 70's in North America with proprietary signalling protocols and shortly afterwards in Europe using analogue MPT1327 technology. The main benefit of trunking is normally seen as spectrum efficiency, or more radio users per RF channel compared with a conventional radio channel for a given Grade of Service (GoS), brought about by the automatic and dynamic assignment of a small number of communication channels shared amongst a relatively large number of users.

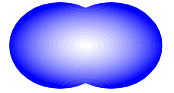
Trunked system offers many benefits



شاهین ارتباط تهران

- improved system access
- communications privacy
- user priority levels for system access
- more efficient utilization of your frequency resources
- flexibility in assigning multiple talkgroup levels
- enhanced dispatching capabilities
- system management capability
- a smooth migration path to future technologies,

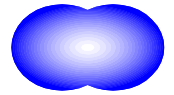
Cellular Concept



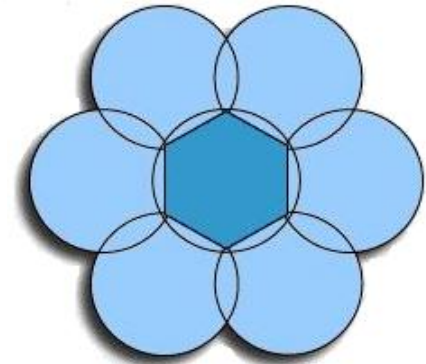
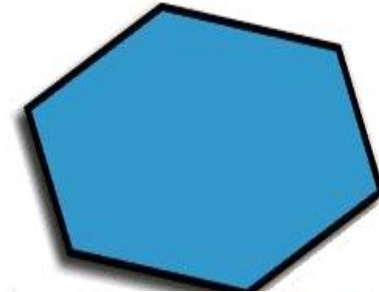
شاهین ارتباط تهران

- Limited number of frequencies:
 - limited channels
 - limited number of users
- Smaller cells:
 - frequency reuse possible
 - more number of users
- As demand increases (more channels are needed):
 - Number of base stations is increased
 - Transmitter power is decreased correspondingly to avoid interference

Cellular Concept

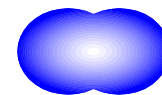


شاهین ارتباط تهران



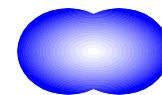
- Cell size:
 - 100 m in cities to 35 km on the country side (GSM)
 - even less for higher frequencies
- Cell shape:
 - Hexagonal is useful for theoretical analysis
 - Practical footprint (radio coverage area) is amorphous
- BS placement:
 - Center-excited cell: BS near center of cell
 - omni-directional antenna
 - Edge-excited cell: BSs on three of the six cell vertices
 - sectored directional antennas

Cellular Concept



شاهین ارتباط تهران

- Advantages of cell structures:
 - higher capacity, higher number of users
 - less transmission power needed
 - more robust, decentralized
- Disadvantages:
 - handover (changing from one cell to another) necessary
 - interference with other cells
 - reduced concentration while driving
 - electromagnetic radiation
 - abuse of private data possible
 - high complexity of the system
- Important Issues:
 - Cell sizing
 - Frequency reuse planning
 - Channel allocation strategies

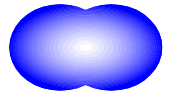


Second Generation

&

Cellular network

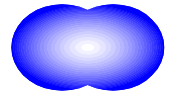
Cellular Network 2ndG



شاهین ارتباط تهران

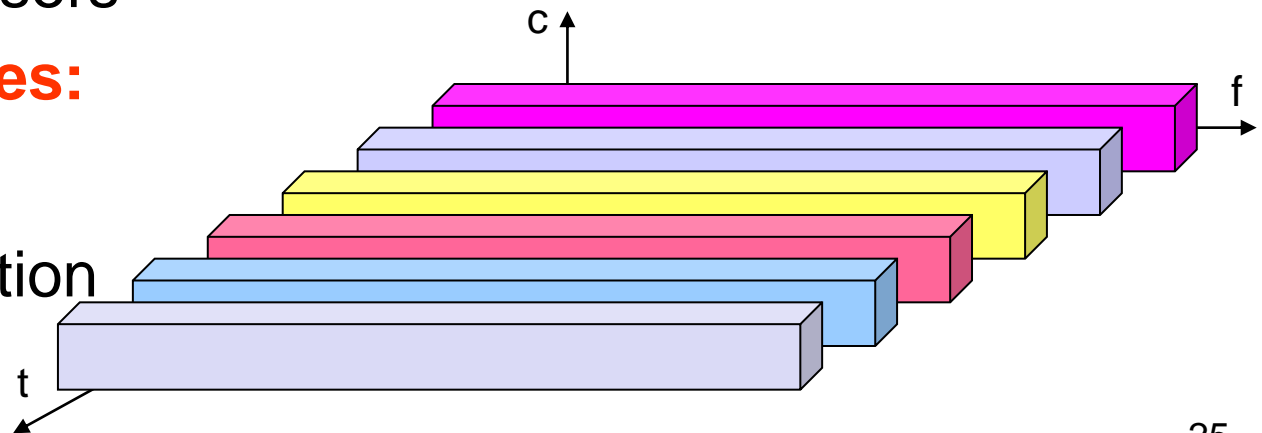
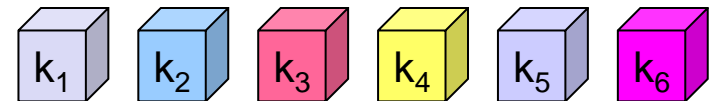
- Cellular Network 2ndG based on digital both voice and modulation
- Using the following methods:
 - TDMA
 - FDMA
 - CDMA
 - OFDM
- Purpose, share resources for several users
- Benefit , spectrum efficiency

TDMA

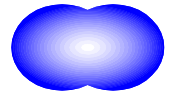


شاهین ارتباط تهران

- A channel gets the whole spectrum for a certain amount of time
- **Advantages:**
 - only one carrier in the medium at any time
 - throughput high even for many users
- **Disadvantages:**
 - Precise synchronization

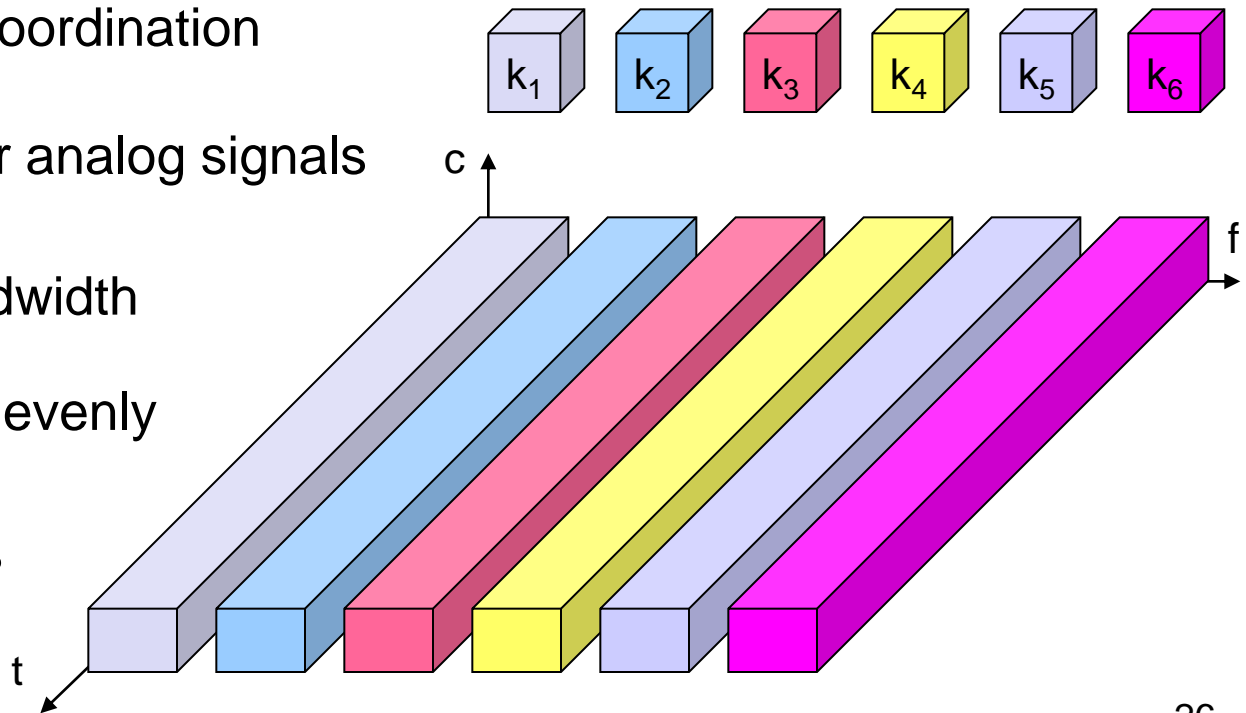


FDMA



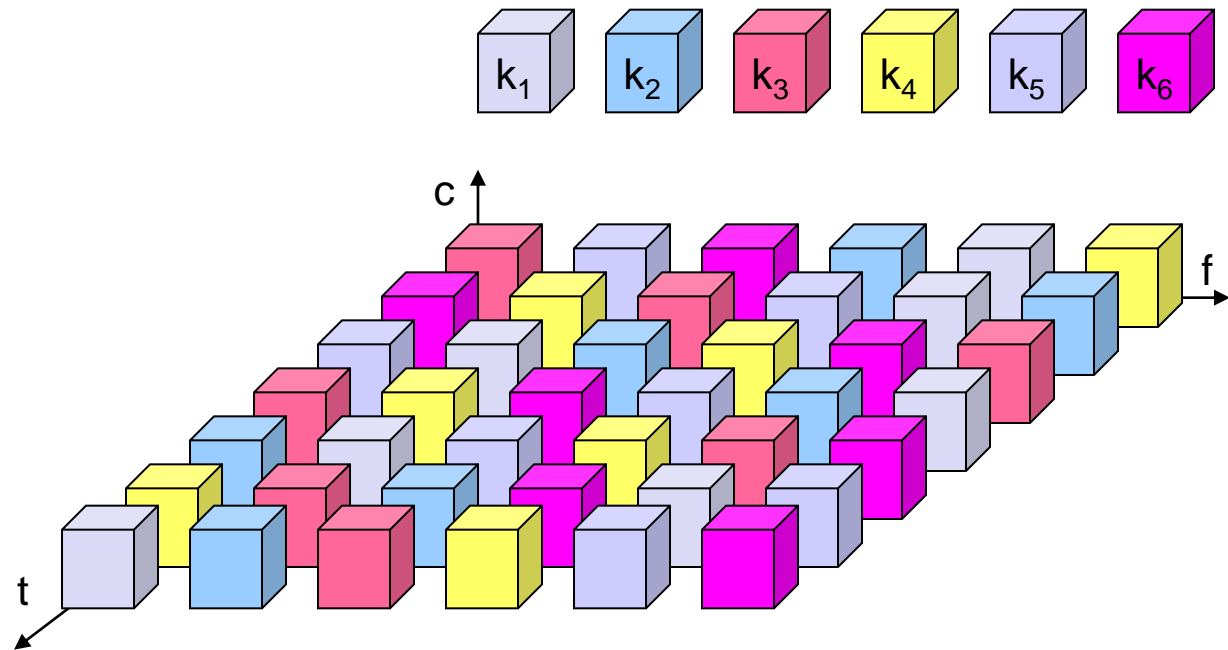
شاهین ارتباط تهران

- Separation of the whole spectrum into smaller frequency bands
- A channel gets a certain band of the spectrum for the whole time
- Advantages:
 - no dynamic coordination necessary
 - works also for analog signals
- Disadvantages:
 - waste of bandwidth if the traffic is distributed unevenly
 - inflexible
 - guard spaces

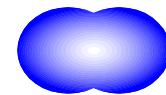


Time and Frequency Multiplexing

- Combination of both methods
- A channel gets a certain frequency band for a certain amount of time

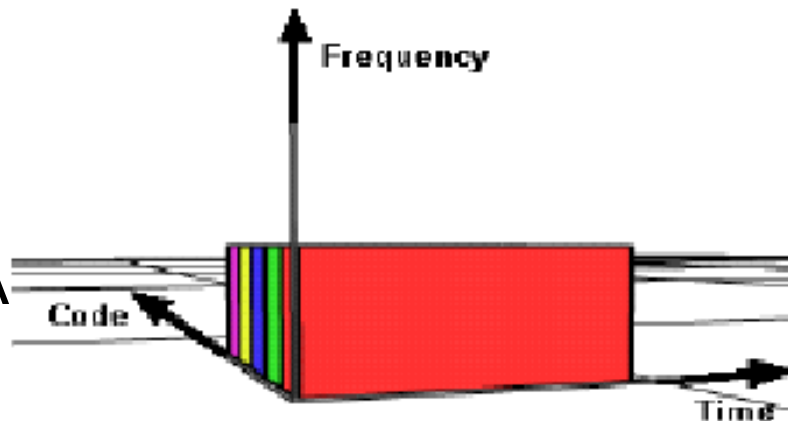


Code division Multiple Access (CDMA)

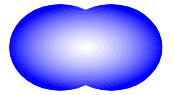


شاهین ارتباط تهران

- Each user have a unique Code
- Code used at BTS and MS to distinguish different user
- A channel gets a certain frequency band for a certain amount of time
- Advantage :
 - No frequency planning
 - Spectrum Efficiency
- NOT used in GSM & TETRA
- WCDMA used at UMTS



Outset of 2ndG

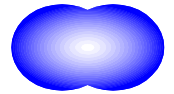


شاهین ارتباط تهران

(GSM) is developed to study and develop a pan-European public land mobile system Requirements

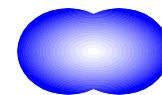
- Good subjective speech quality
- Low terminal and service cost
- Support for international roaming
- Ability to support handheld terminals
- Support for range of new services and facilities
- Spectral efficiency
- ISDN compatibility

GSM History

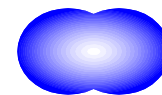


شاهین ارتباط تهران

- In 1989
 - European Telecommunications Standard Institute (ETSI) formed
 - GSM responsibility was transferred to the European Telecommunication Standards Institute (ETSI)
- In 1990
 - Phase I of the GSM specifications were published
 - Only at 900 MHz
- In mid-1991
 - Commercial service was started
- In 1992
 - Digital Cellular System (DCS) 1800 developed
 - Upper Band version of GSM 900
 - Up link (1785-1710MHz)
 - Down link (1880-1805MHz)
 - Lunch the first GSM in Fenland
 - 7 netowrk was lunched until september 1992



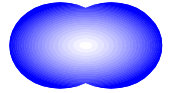
- In 1993
 - Lunch GSM in south Africa (Telecom 93)
- In 1994
 - Personal Digital Cellular (PDC) developed
 - Started GSM II with Fax / Data
- In 1995
 - PCS 1900—Canada (North American version of GSM 900)
 - 117 PLMN in the world
- In 1996
 - PCS—United States
 - Use pre paid SIM
- In 1998
 - 180 million subscriber in GSM



امتیازات GSM

- استفاده کارا از فرکانسهای رادیویی
- کیفیت بالاتر سیگنال صحبت در مقایسه با سیستمهای آنالوگ
- امکان انتقال اطلاعات دیتا از طریق GSM
- رمزنگاری مکالمه و تضمین امنیت اطلاعات مشترک
- امکان ارائه سرویسهای جدید در مقایسه با سیستمهای آنالوگ به علت تطابق با سیستمهای ISDN.
- امکان پذیر بودن رومینگ بین کشورهایی که از GSM استفاده می کنند.
- گستردگی بازار تقاضا

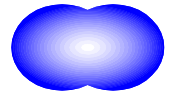
Emerging GSM



شاهین ارتباط تهران

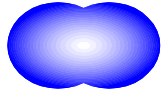
- GSM uses a technique called Time Division Multiple Access (TDMA).
- A single GSM RF carrier can support up to eight mobile subscribers simultaneously.
- Time is divided into discrete periods called "time slot". The time slots are arranged in sequence and are conventionally numbered 0 to 7. Each repetition of this sequence is called a "TDMA frame"

The GSM Specification

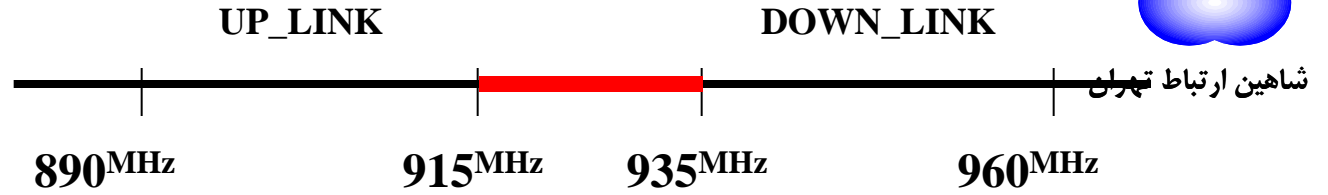


شاهین ارتباط تهران

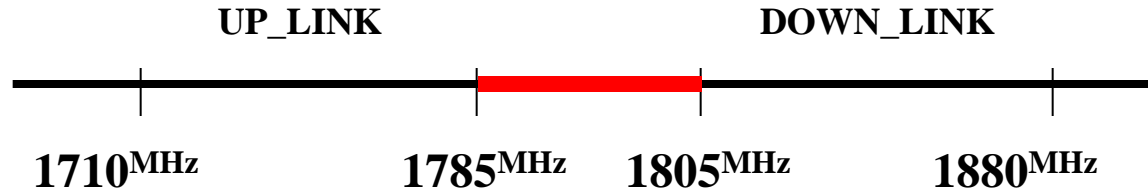
- Access Method **TDMA/FDMA**
- Freq. Band **900/1800**
- No. of Channel **124** radio carriers
- Max no. of user channels $124 * 8 = 992$ channels
- Channel BW **200** KHz
- Uplink Freq. BW **890** to **915**MHz (MS→BTS)
- Downlink Freq. BW **935** to **960**MHz (BTS→MS)
- No, of channel/carrier **8** channels/carrier
- Modulation Digital **GMSK** (Gaussian Minimum Shift Keying that is a type of phase modulation)
- Speech Coding RPE-LTP (Regular pulse excited - long term prediction)
- Speech coding bit rate **13** kbps
- Data coding bit rate **12** kbps
- Service Voice and Data
- No. of Sub. **500** M



GSM_900

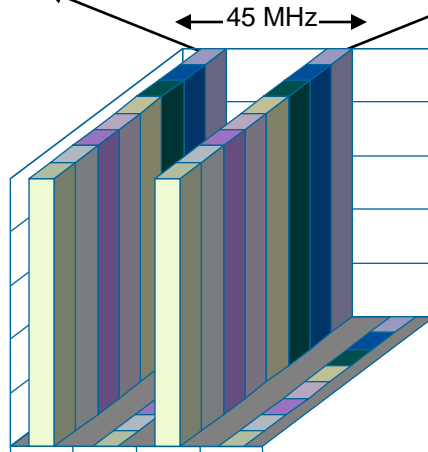


GSM_1800



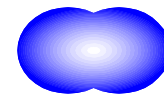
MS Transmission Band :
890 – 915 MHz

BS Transmission Band :
935 – 960 MHz



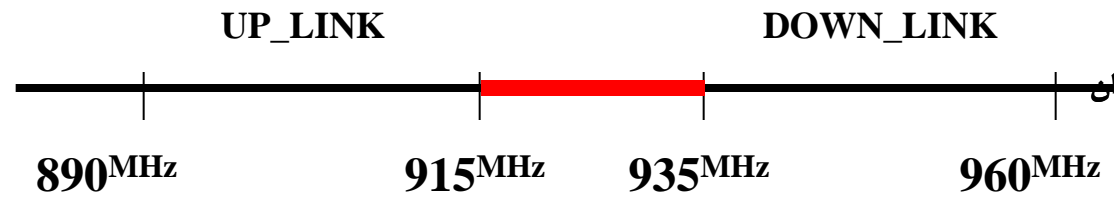
F1 F2 F1' F2'

Frequency

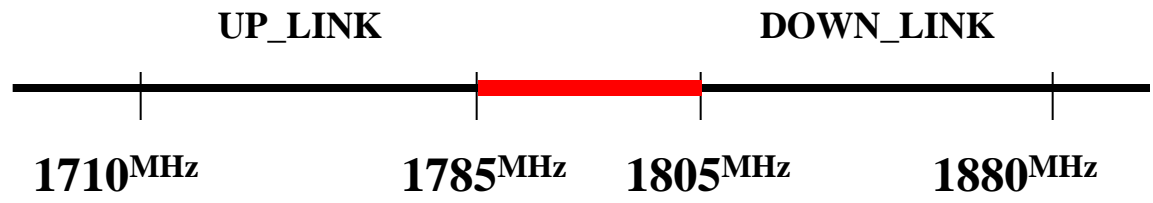


شاهین ارتباط تهران

GSM_900

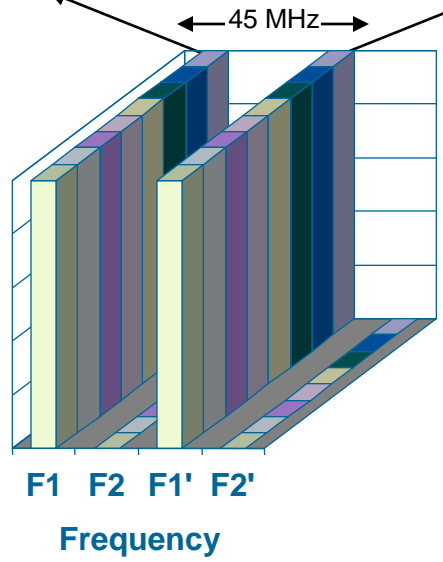


GSM_1800

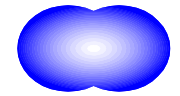


MS Transmission Band :
890 – 915 MHz

BS Transmission Band :
935 – 960 MHz



Carrier Frequency Range



شاهین ارتباط تهران

GSM 900

Uplink: 890 - 915 Mhz
Downlink: 935 - 960 Mhz

Carrier Pairs (in Mhz)

890.0	935.0
890.2	935.2
890.4	935.4
....
....
914.8	959.8
915.0	960.0

124 Carriers

Duplex Frequency = 45 Mhz

$$F_u(n) = 890 + 0.2 * n \quad 1 \leq n \leq 119$$

$$F_d(n) = F_u(n) + 45$$

GSM 1800

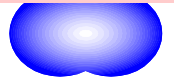
Uplink: 1710 - 1785 Mhz
Downlink: 1805 - 1880 Mhz

Carrier Pairs (in Mhz)

1710.0	1805.0
1710.2	1805.2
1710.4	1805.4
....
....
1784.8	1879.8
1785.0	1880.0

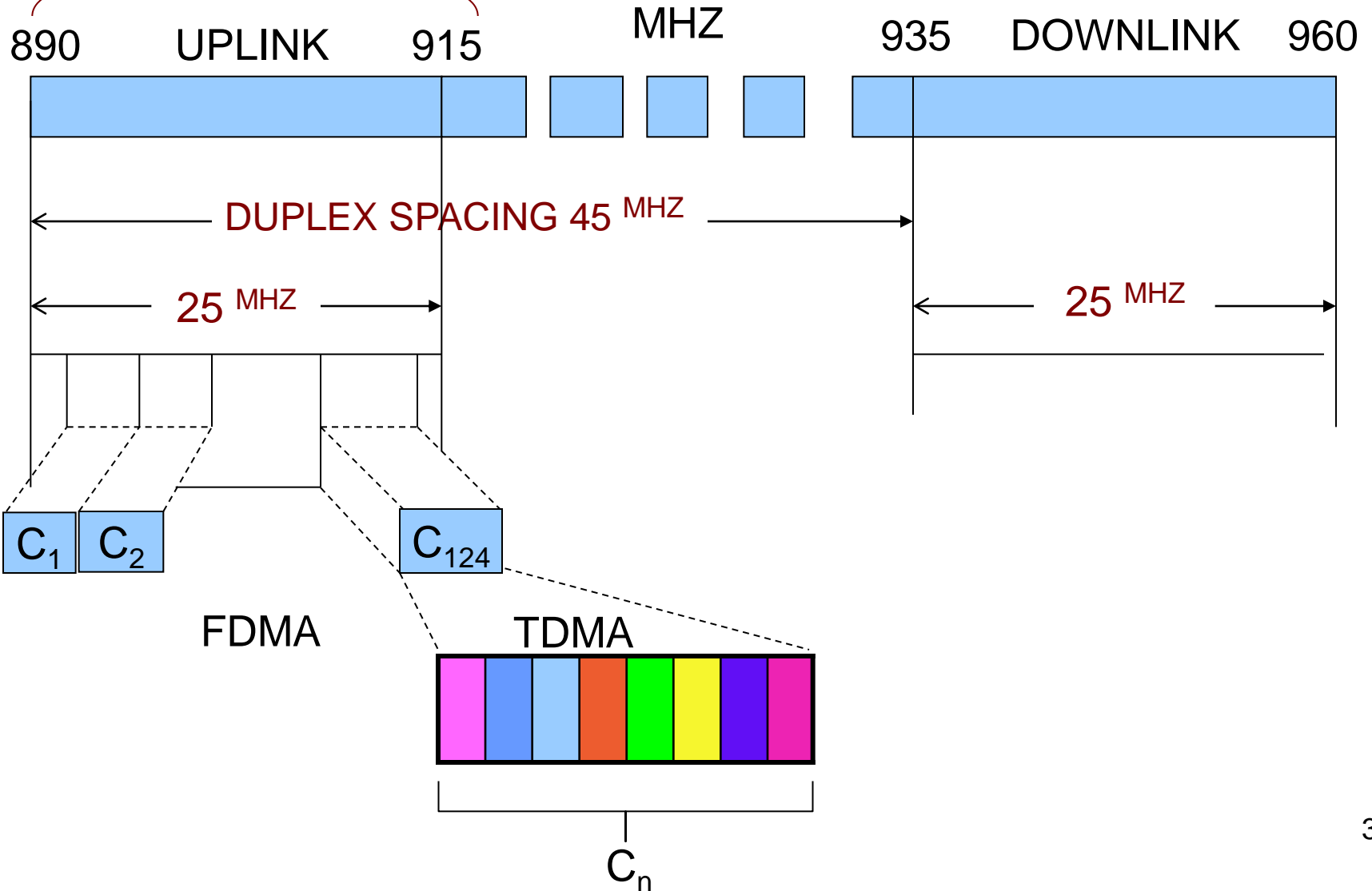
374 Carriers

Duplex Frequency = 95 Mhz



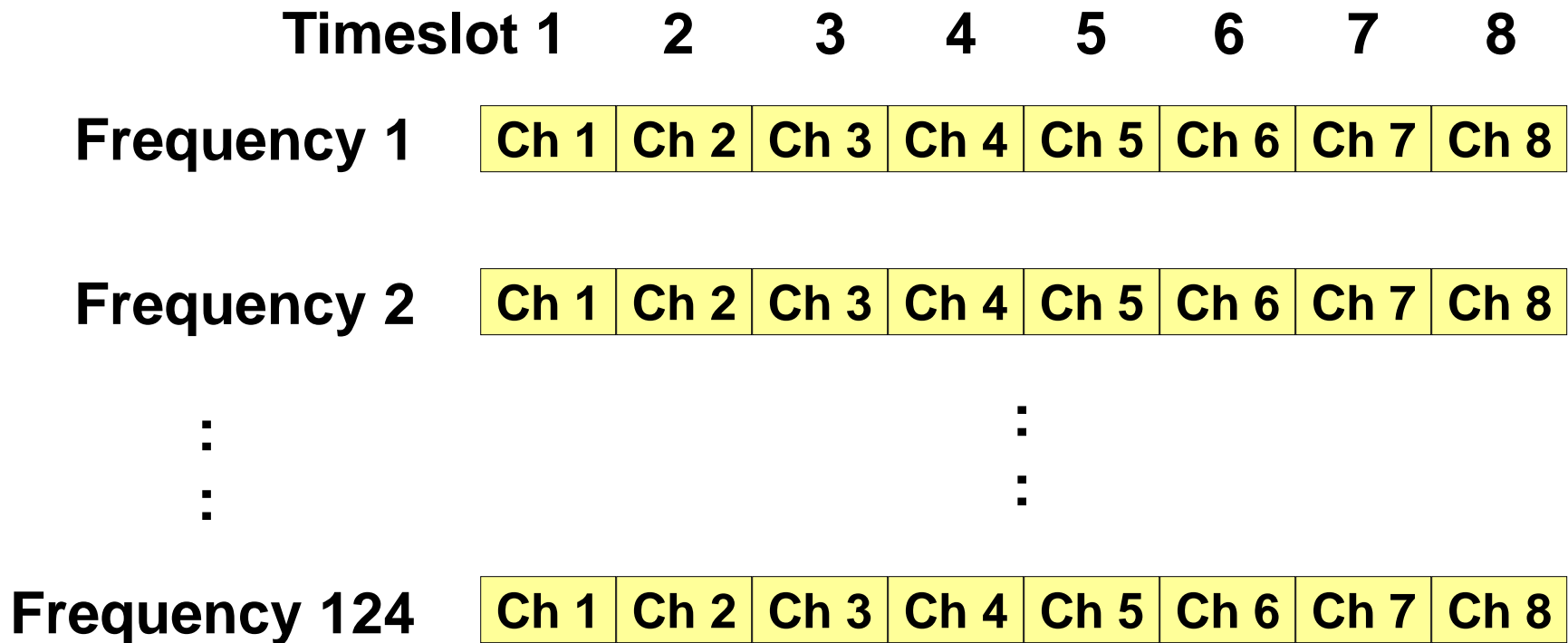
MOBILE STATION TRANSMIT BAND

MOBILE STATION Receive BAND

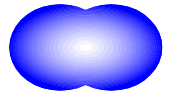


GSM Physical Channels

← TDMA frame = 4.615 ms →



Cellular Systems

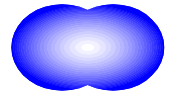


شاهین ارتباط تهران

- Different use requires different tools
 - GSM is excellent system for cellular telephony
 - Professional mobile radio needs appropriate technology
- Could GSM develop to a Professional Mobile Radio system?
 - Technical reasons
 - Cost reasons
 - Market strategy reasons

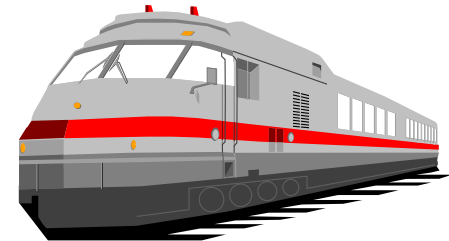


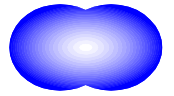
Build PMR by GSM?



شاهین ارتباط تهران

- Technical reasons
 - Direct mode
 - 300 millisecond call setup
 - semi-duplex group communication
- Cost reasons
 - Only high volumes make cellular phones cheaper compared with professional radios
 - Easier to develop a TETRA system than modify GSM
- Market strategy reasons
 - Too small volumes for cellular phone industry
 - Too small volumes for GSM infra industry
 - Too risky for GSM operators

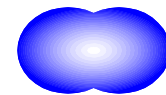




شاهین ارتباط تهران

TETRA

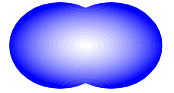
About TETRA



شاهین ارتباط تهران

Terrestrial Trunked Radio (TETRA) is a digital trunked mobile radio standard developed by the European Telecommunications Standards Institute [\(ETSI\)](#).

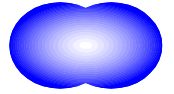
About TETRA



شاهین ارتباط تهران

The ability for full interoperability between different manufacturer's products is a distinct advantage of open standards developed by ETSI. As the TETRA standard is supported by several independent manufacturers this increases competition, provides second source security and allows a greater choice of terminal products for specific user applications.

What is TETRA?



شاهین ارتباط تهران

TERrestrial TRunked Radio

- New standard for European radiocommunications
- Defined by European Telecommunications Standards Institute ETSI
- Fully digital Professional Mobile Radio system
- Provides high degree of security and reliability
- Supported by major manufacturers
- Will bring a genuine multivendor market
- Will be taken into use in most European countries

TETRA compared with Analogue systems

- TETRA is a **TDMA** system

(**T**ime **D**ivision **M**ultiple **A**ccess)
- TETRA is a **DIGITAL** system
- TETRA is a **CONTROLLED LINK** system

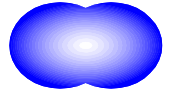
What is ETSI?



European Telecommunications Standards Institute

- Produces telecommunications standards for the EU & other Western Europe
- European Telecommunication Standards (ETS) are mandatory in the member countries
- Joint forum of (government) regulators, telecoms operators and equipment vendors
- Standards approved after Public Enquiry and Final Voting (majority makes the decision)

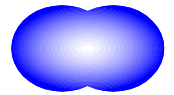
TETRA users



شاهین ارتباط تهران

- *Public Safety*
- *Oil & Gas*
- *Transportation*
- *Utilities*
- *Government*
- *Military*
- *PAMR*
- *Commercial & Industry*

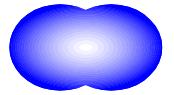
Conventional PMR problems solved by Trunking



شاهین ارتباط تهران

Conventional PMR Problem	Trunking Solution
Contention	All call requests are handled on the control channel for immediate call processing or in order of queue priority if the system is busy.
Manual Switching of Channels	Automatic cell handover takes away the need for manual channel selection
Inefficient Channel Utilization	The automatic and dynamic assignment of a small number of communication channels shared amongst a relatively large number of users ensures an equal grade of service for all radio users on the system.
Lack of Privacy	The dynamic and random allocation of channels makes it more difficult for a casual eavesdropper to monitor conversations
Radio User Abuse	Abuse is minimized as the identity of all radio users and the time and duration of messages are known and can therefore be easily traced to the abuser.

Compare TETRA & MPT1327



شاهین ارتباط تهران

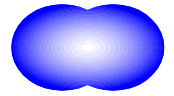
Subject	TETRA	MPT1327
Voice	Digital	Analogue
Circuit mode data (kbps)	Up to 28.8	Up to 9.6
Manufacture	Unlimited	limited
End to end encryption	yes	no
Roaming	Unlimited	limited
Hand over	yes	no
System development	non expensive	expensive
Eavesdropping	difficult	easy
Radio system	TDMA & FDMA	FDMA
Terrific capacity in 25 KHz bandwidth	4	1
Dual watch	yes	no
Packet switching	Yes	No

The main objectives

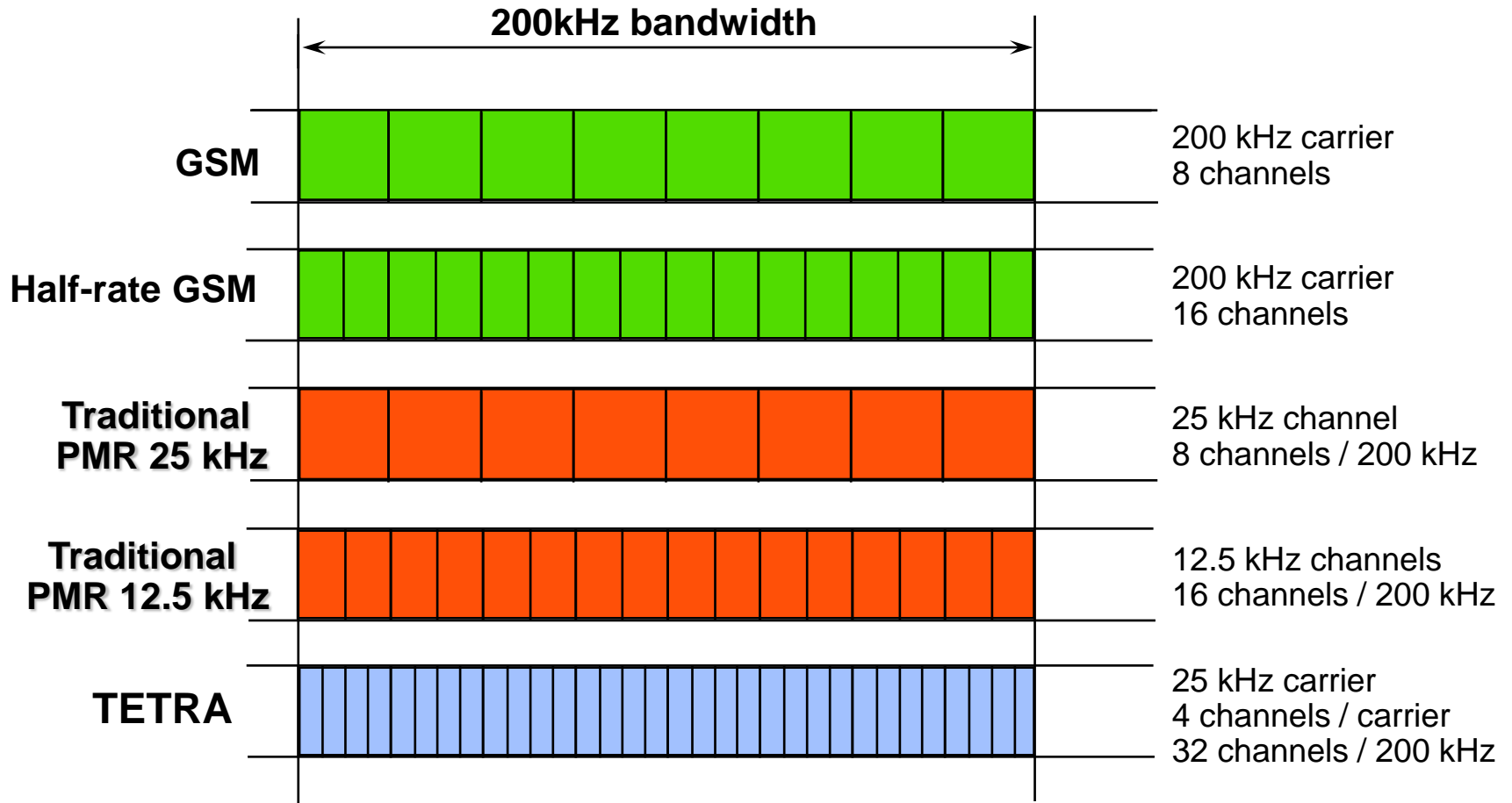


The main objectives of the TETRA Association are to promote the TETRA standard and to ensure multi-vendor equipment interoperability.

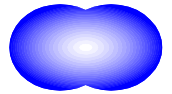
Comparative spectrum efficiency



شاهین ارتباط تهران

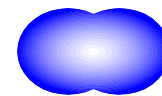


TETRA v GSM



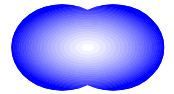
شاهین ارتباط تهران

	<i>TETRA</i>	<i>GSM</i>
<i>RF Bandwidth</i>	<i>25kHz</i>	<i>200kHz</i>
<i>Bandwidth per slot</i>	<i>6.25kHz</i>	<i>25kHz</i>
<i>Call Set-up time</i>	<i><300msec</i>	<i>10 - 15 seconds</i>
<i>Mode</i>	<i>Person to person + Person to group</i>	<i>Person to person only</i>
<i>Encryption</i>	<i>End to End</i>	<i>Air Interface only</i>
<i>Direct Mode</i>	<i>3 types</i>	<i>None</i>
<i>Max Data Rate</i>	<i>28.8kbit/s</i>	<i>9.6kbit/s</i>
<i>Simultaneous voice and data</i>	<i>Yes</i>	<i>No</i>



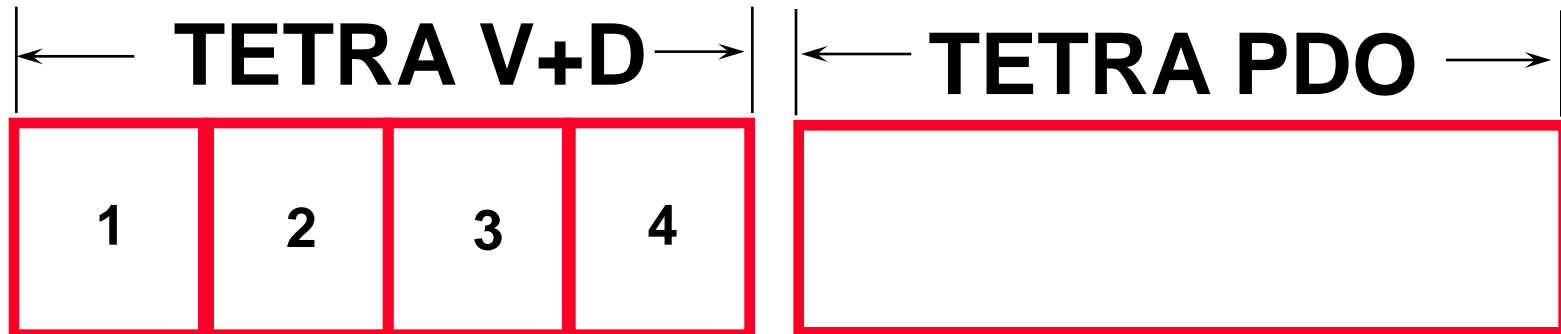
شاهین ارتباط تهران

TETRA STANDARDS



سازمان ارتباطات تهران

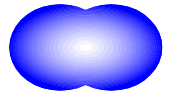
- Modulation $\pi/4$ DQPSK
- Bit-rate 36000 bps @ 25 kHz Channel Spacing both uplink and downlink
- Packet Data Optimised(PDO) and Voice+Data (V+D) using same RF platform
- PDO offering packet switching at 36000 bps gross data rate
- V+D offering 4 TDMA services on a single 25 kHz RF channel



TDMA Technology
Time Division Multiple Access
25 kHz
Channel

STM/STMA Technology
Statistical Multiplexing/Multiple Access
25 kHz
Channel

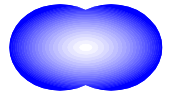
TETRA parameters



شاهین ارتباط تهران

Channel spacing	25 kHz
Modulation	PI/4 DQPSK
Channel data rate	36 kbits/s
Speech code rate	appr. 4.8 kbits/s
Access method	TDMA, 4 timeslots
User data rate	7.2 kbits/s per timeslot
Variable data rate	2.4 up to 28.8 kbits/s
Interfaces	6 standardized interfaces

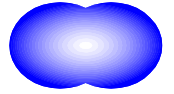
TETRA is the Economic Technology



شاهین ارتباط تهران

- First, TETRA was introduced in late 1991.
- First TETRA products were available in late 1996.
- Two families of standards have been produced by TETRA:
 - Voice plus Data (V+D) standards.
 - Data only (Packet Data Optimized standards, PDO).

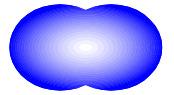
TETRA is the reliable technology



شاهین ارتباط تهران

- Wide area trunked networks provide means to built-in redundancy and fault tolerance
- Effective priority schemes ensure delivery of important messages
- Direct mode communications, mobile repeater and gateway functions give added reliability and availability

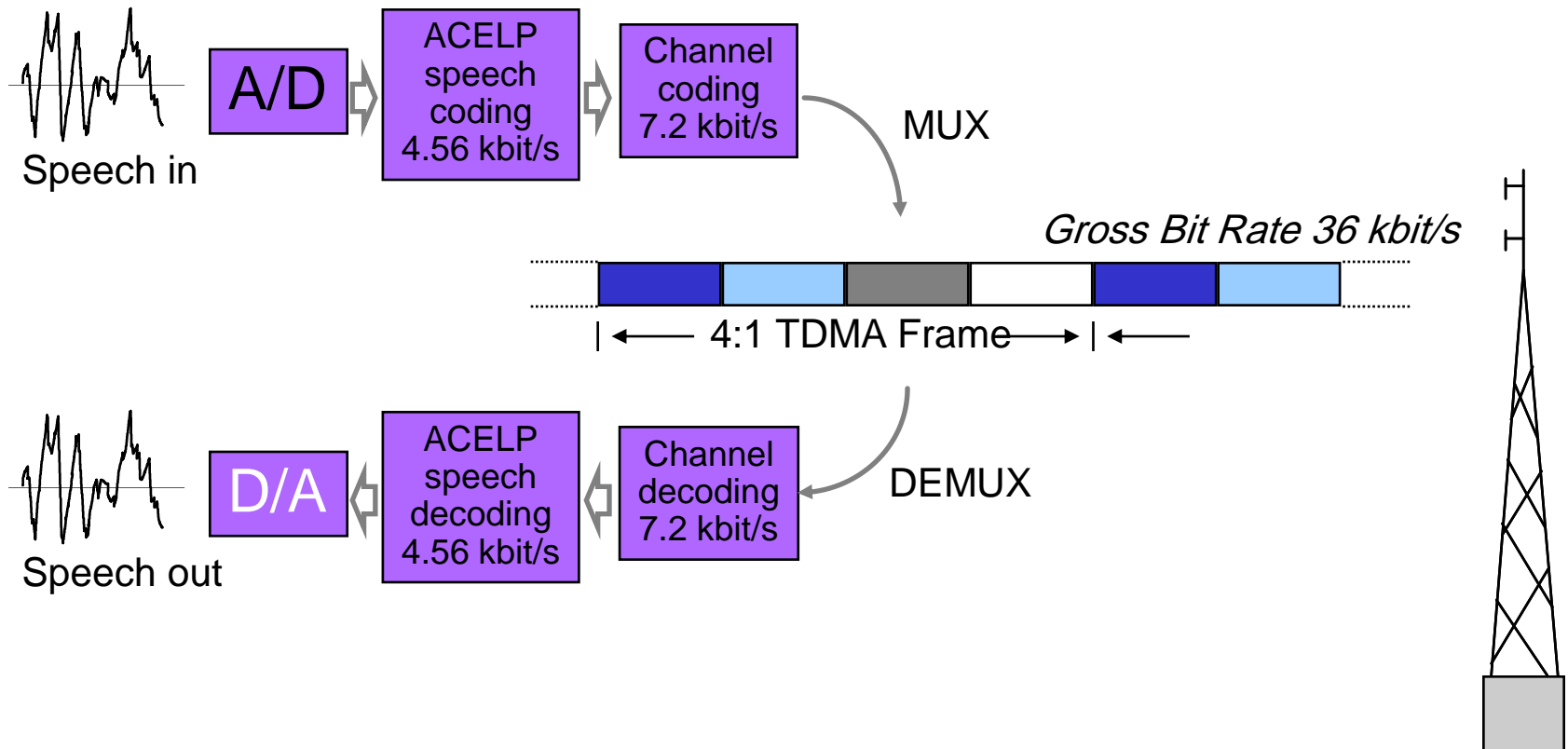
TETRA Facilities



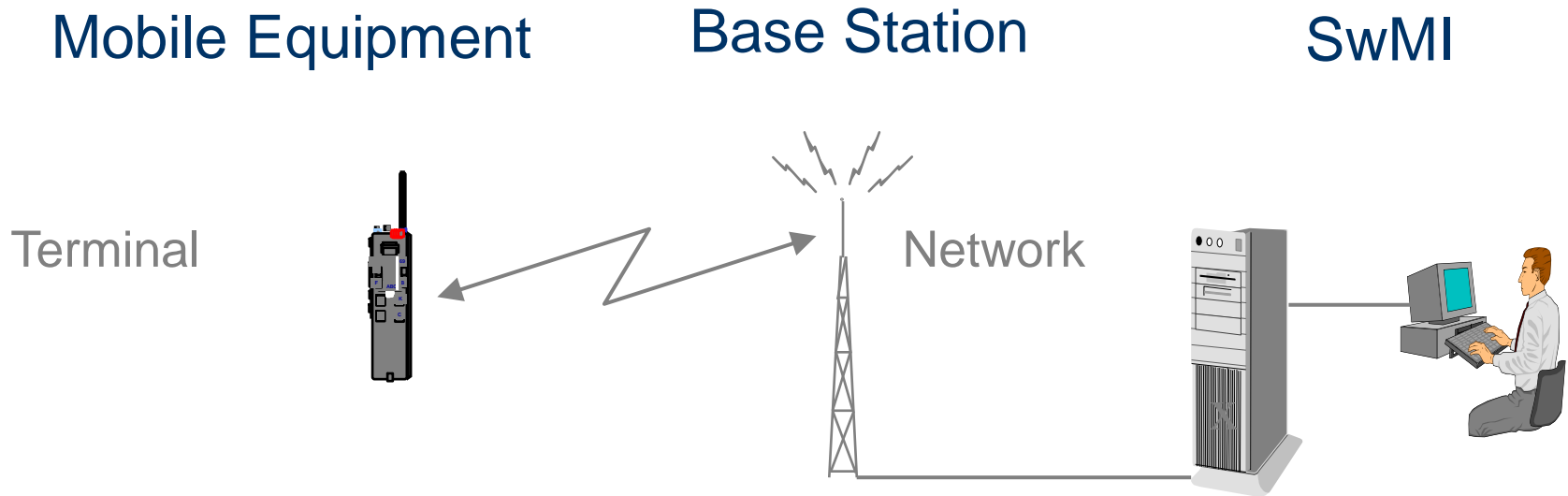
شاهین ارتباط تهران

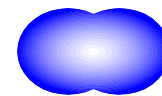
- *Voice Services*
- *Group Call (commonly called 'all informed net' and 'talk group call')*
- *Pre-Emptive Priority Call (Emergency Call)*
- *Call Retention*
- *Priority Call*
- *Dynamic Group Number Assignment (DGNA)*
- *Ambience Listening*
- *Call Authorized by Dispatcher*
- *Area Selection*
- *Late Entry*
- *Data Services*
- *Short Data Service*
- *Packet Data*

Speech Codec & TDMA Frame



TETRA Construction

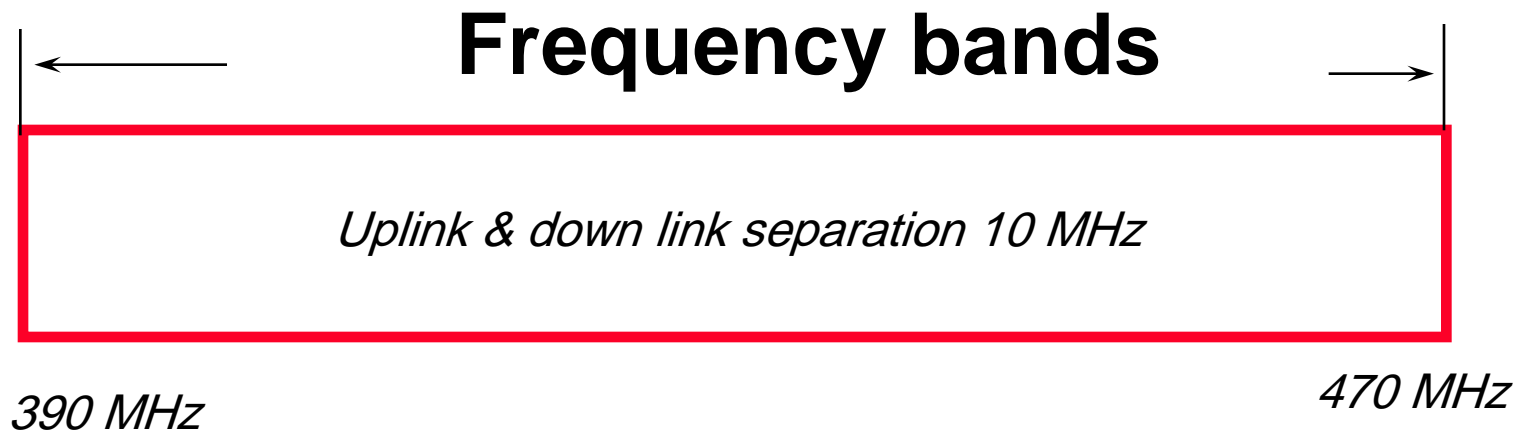


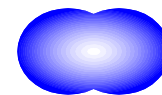


شاهین ارتباط تهران

Frequency Allocation

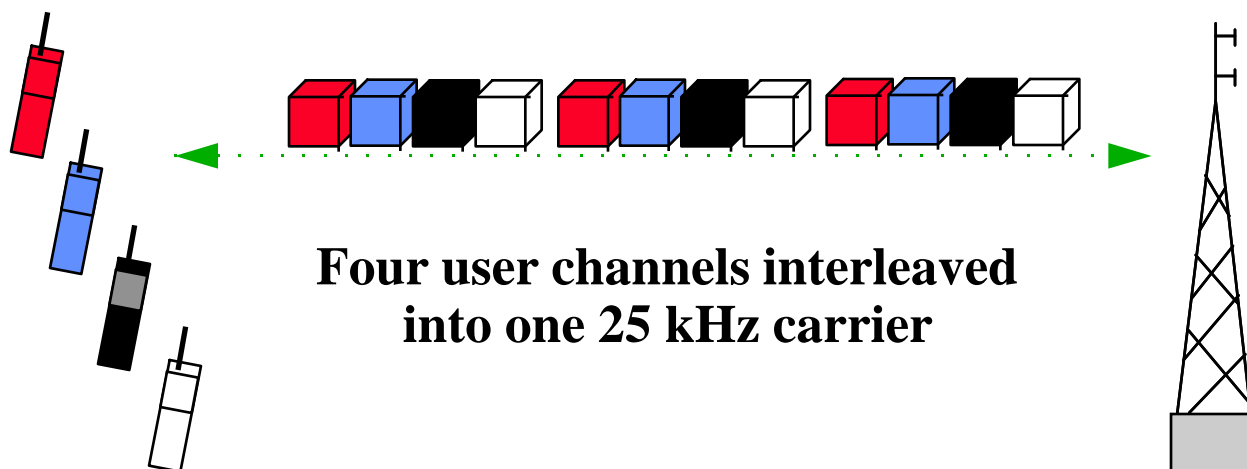
In practice , spectrum for TETRA systems are at 390 to 470 MHz



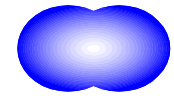


TETRA TDMA

- 4:1 TDMA (Time Division Multiple Access)
- 4 logical channels
- 25 kHz carrier spacing
- speech calls use one channel
- data calls can use up to 4 channels (multi-slot data)

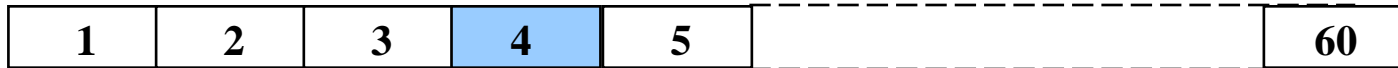


TDMA Frame Structure



شاهین ارتباط تهران

Hyperframe (61.2s)



Multiframe (1.02s)



control
frame

TDMA frame (56.67ms)

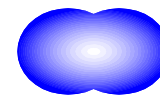


Time slot (14.167ms)
= 510 modulating bits

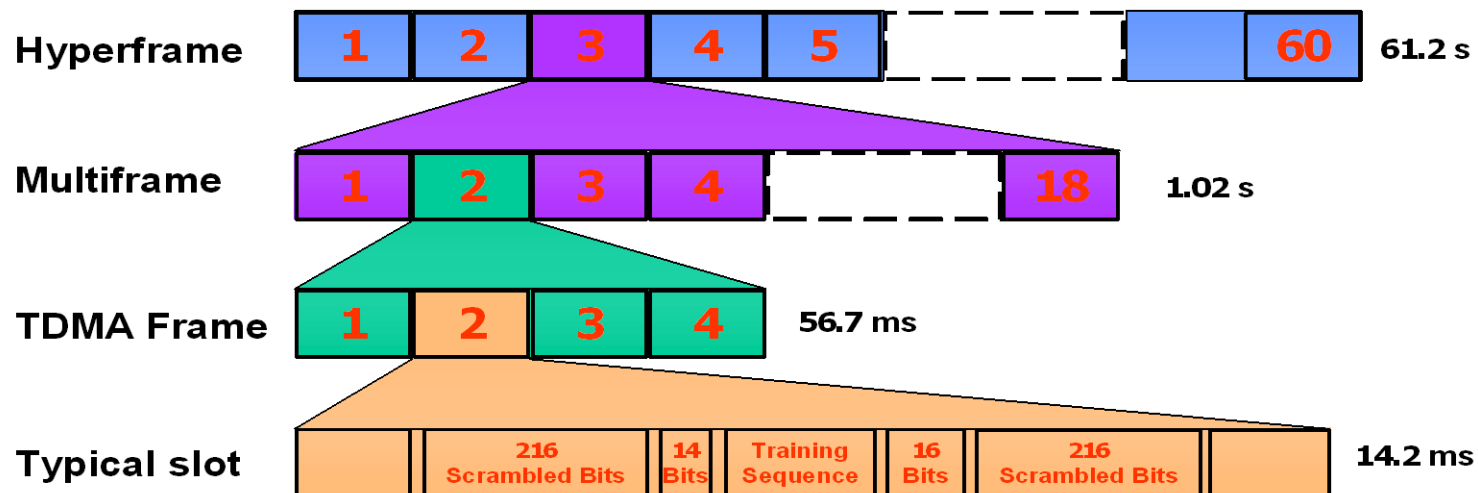


Slow Associated Control CHannel (SACCH).

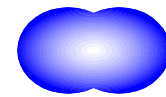
Gross bit rate $17 \times 510 \text{ bits} / 1.02 \text{ s} = 8.5 \text{ kbits/s/channel}$



Air Interface - TDMA Illustrated

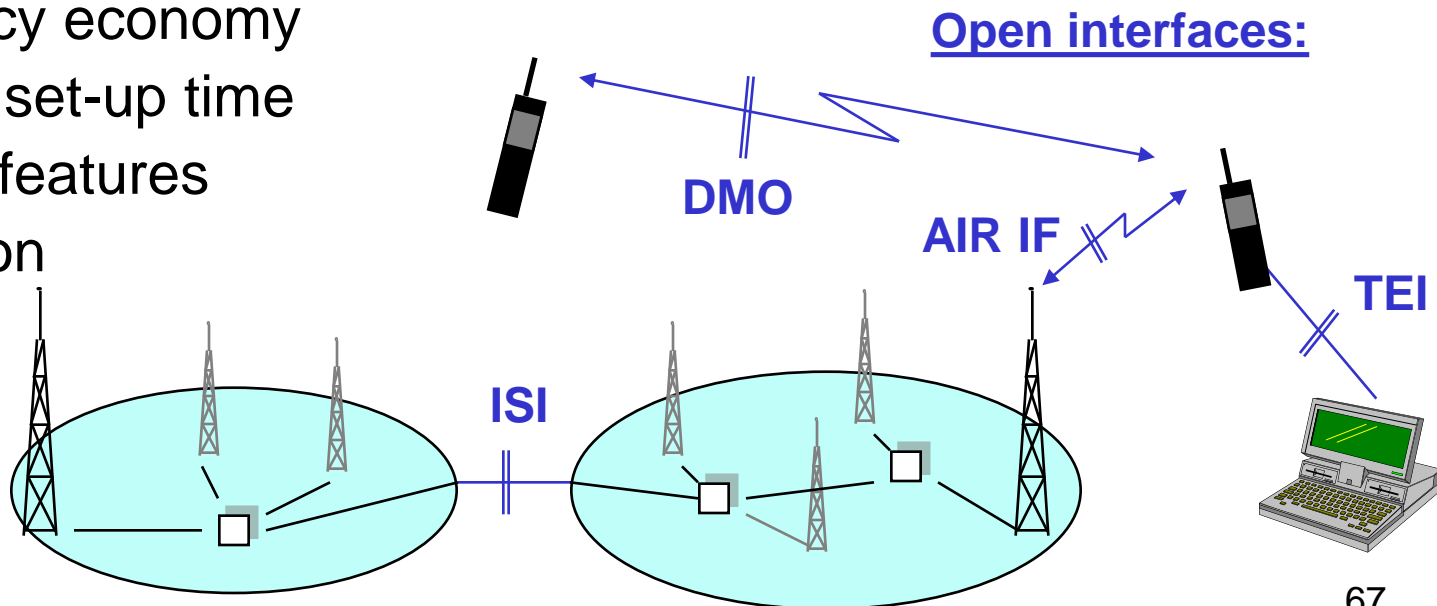


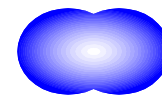
TETRA is superior PMR technology



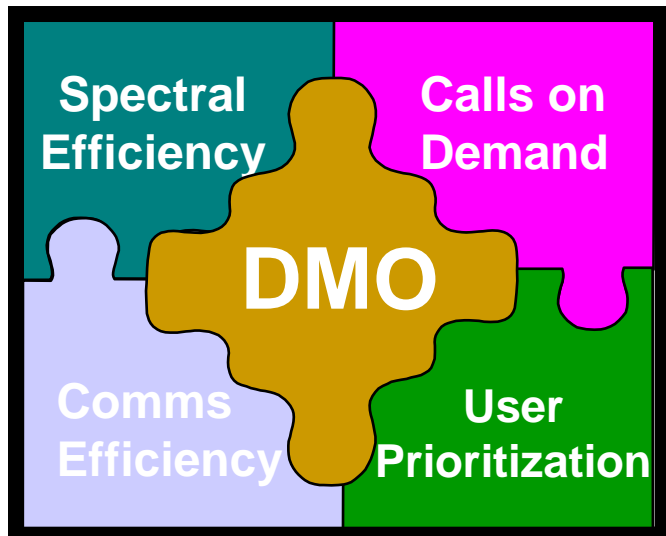
شاهین ارتباط تهران

- Addressing the critical needs of many user segments
- Better group communications support than ever before
- Direct mode communication between radios
- Packet data and fast data transfer services
- Over-the-air programming of radios
- Frequency economy
- Fast call set-up time
- Security features
- Encryption



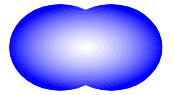


The Trunking & TETRA



- Trunking offered many benefits over conventional communications and was a great success in the market
- It missed just one feature that conventional communications offered - direct terminal to terminal communication
- TETRA's multi-mode capability offers the **best of both worlds** !! Trunking and Direct Communications in a single terminal.

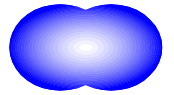
DMO Characteristics



شاهین ارتباط تهران

- Normal DMO enables 1 conversation per carrier (i.e. 1 per 4 timeslots)
- Transmitting radio acts as 'Master' on a single timeslot
- Receiving radio is 'Slave' on a single timeslot
- In normal mode, two time slots are used, two are free
- In Frequency Efficient Mode, all four timeslots are used (2x2) enabling two conversations per carrier

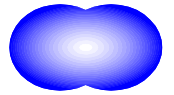
Basic DMO Benefits



شاهین ارتباط تهران

- Operation outside the coverage of Trunking Infrastructure
- Gives extra capacity when trunked network is highly loaded
- Operations in poor signal strength areas
- Fall-back operation when the Trunking Infrastructure system is inoperative
- Covert Operations - cannot be monitored by Control
- 'Stripline' applications (power, oil, water distribution lines) not requiring trunked network capacity
- Communication takes place on a *single* carrier

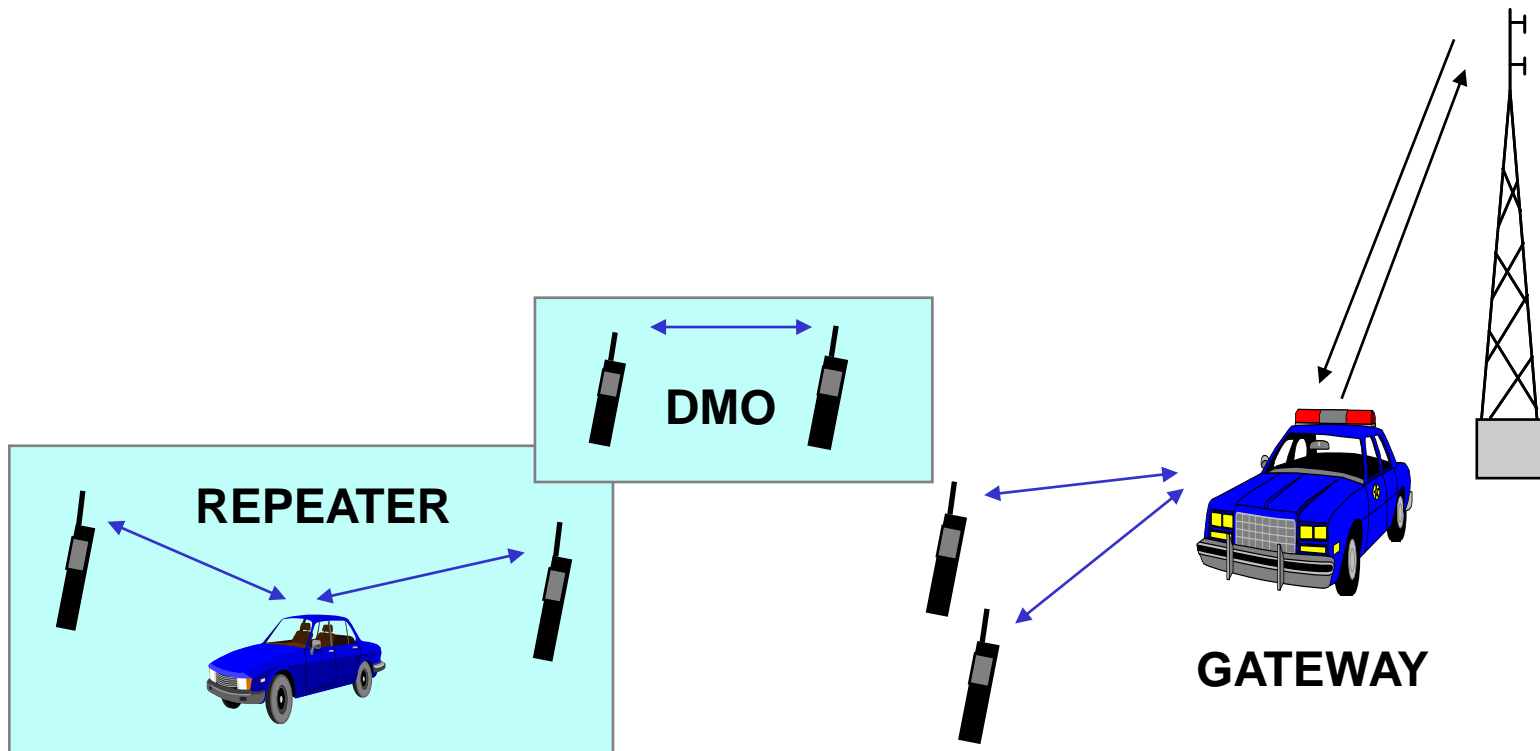
Key DMO Services

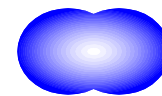


شاهین ارتباط تهران

- Group & Individual Voice Calls
- Emergency Calls
- Circuit Mode Data (up to 7.2kbps)
- Short Data Services (SDS)
- Status Messages
- Late Entry
 - Just switched on
 - Switching from another DM channel
 - Returning to coverage area
 - Switching from Trunked Mode to DM
- Encryption
- Over the Air Rekeying (OTAR)

DM & Dual Watch





Direct Mode AI Scenarios (1)



1. INDIVIDUAL CALL



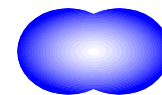
2. GROUP CALL



3. DUAL WATCH



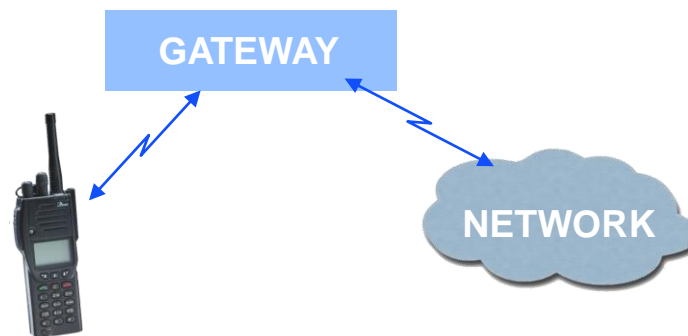
4. MANAGED DIRECT MODE



Direct Mode AI Scenarios (2)



5. DIRECT MODE REPEATER



6. DIRECT MODE GATEWAY



7. DIRECT MODE REPEATER/ GATEWAY



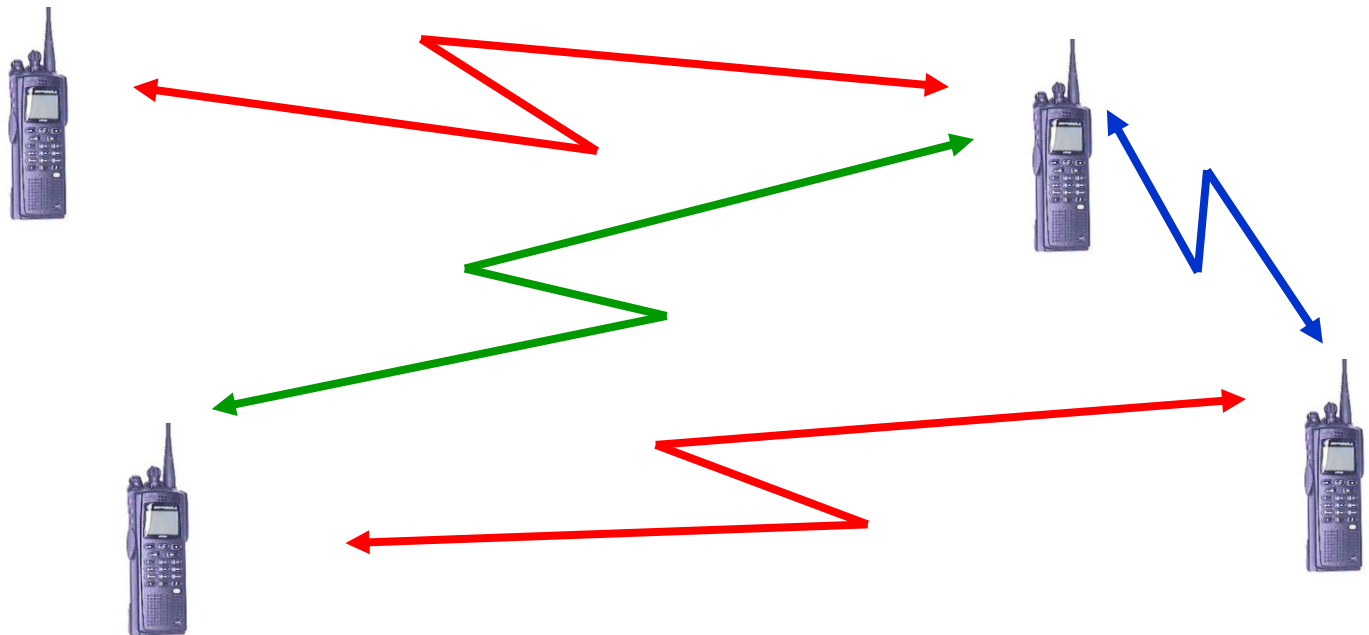
8. MANAGED REPEATER/ GATEWAY

Direct Mode Operation (DMO)

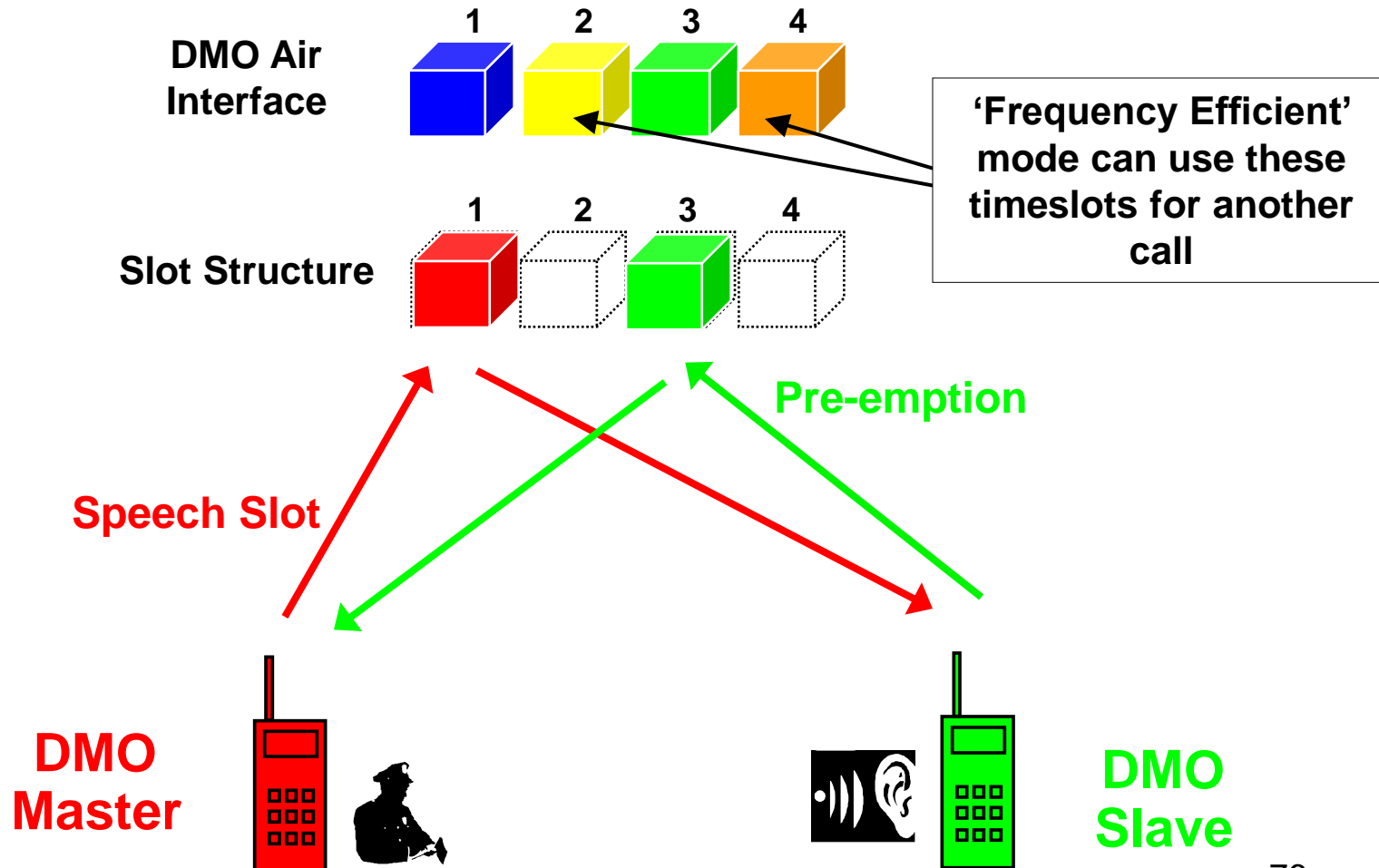


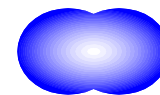
- Direct Mode (DM) is direct communication between two TETRA DM terminals.....

...or several TETRA DM terminals or mobile stations without the use of a trunking network infrastructure.

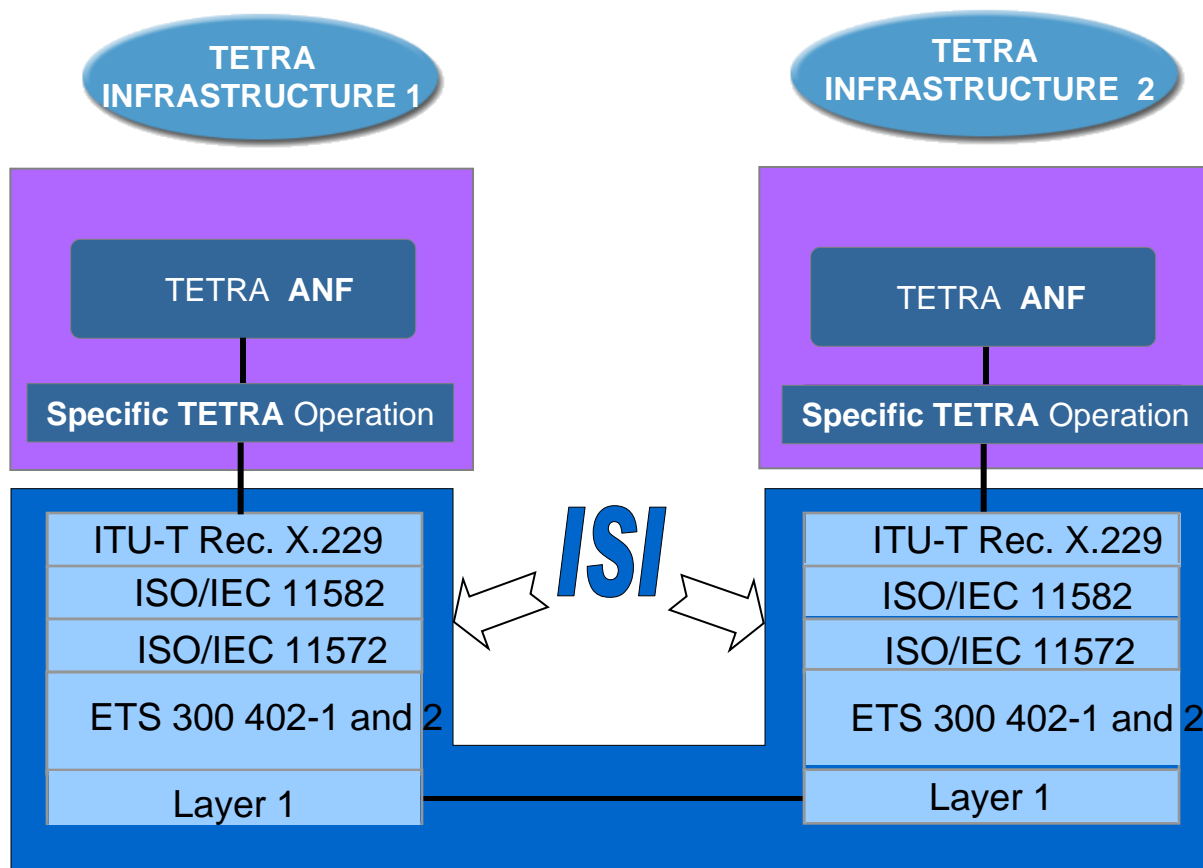


'Back-to-Back' DMO



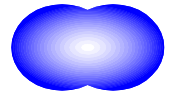


ISI : Protocol Stack

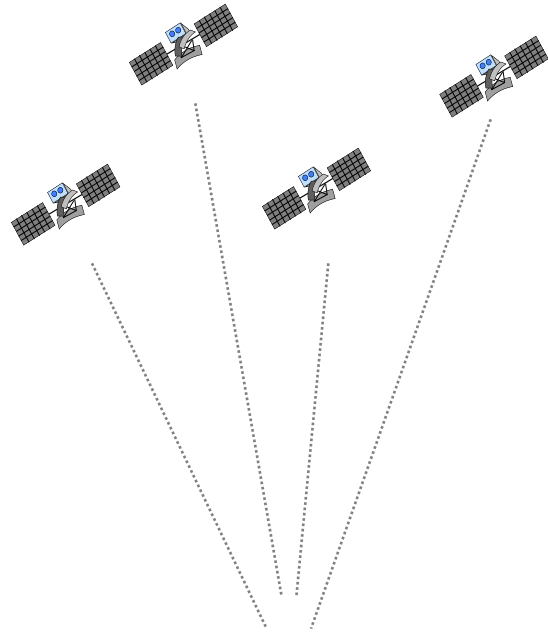


PRIVATE SIGNALLING SYSTEM 1 (PSS1) USED IN ISI STANDARD

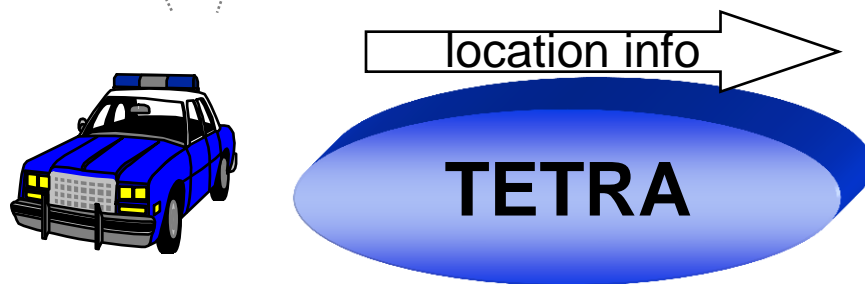
AVL - Automatic Vehicle Location



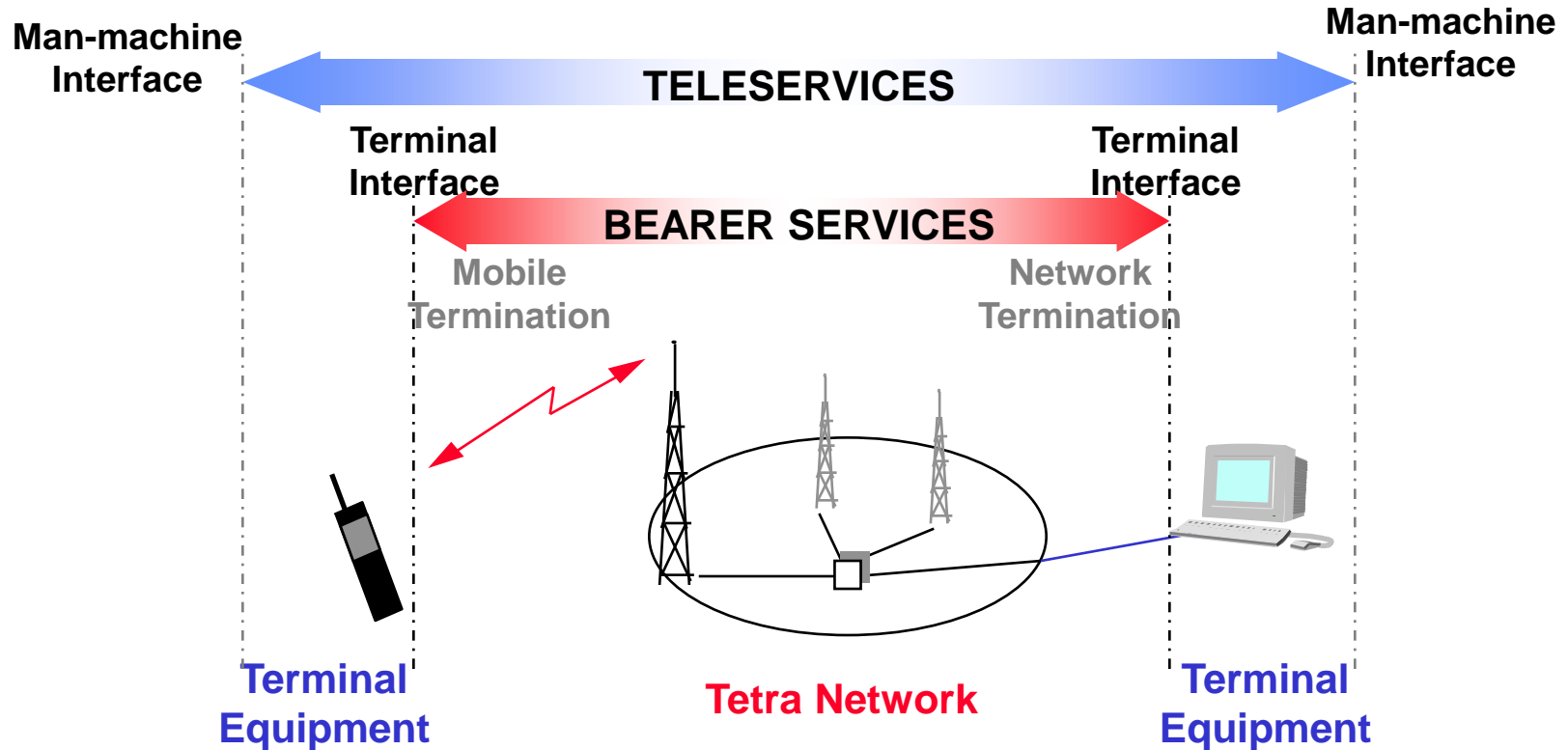
شاهین ارتباط تهران



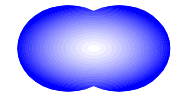
- Mandatory application in all PSS projects
- SDS messaging
- No extra radio terminal needed in the vehicle
- New AVL systems have area triggering, time triggers etc.



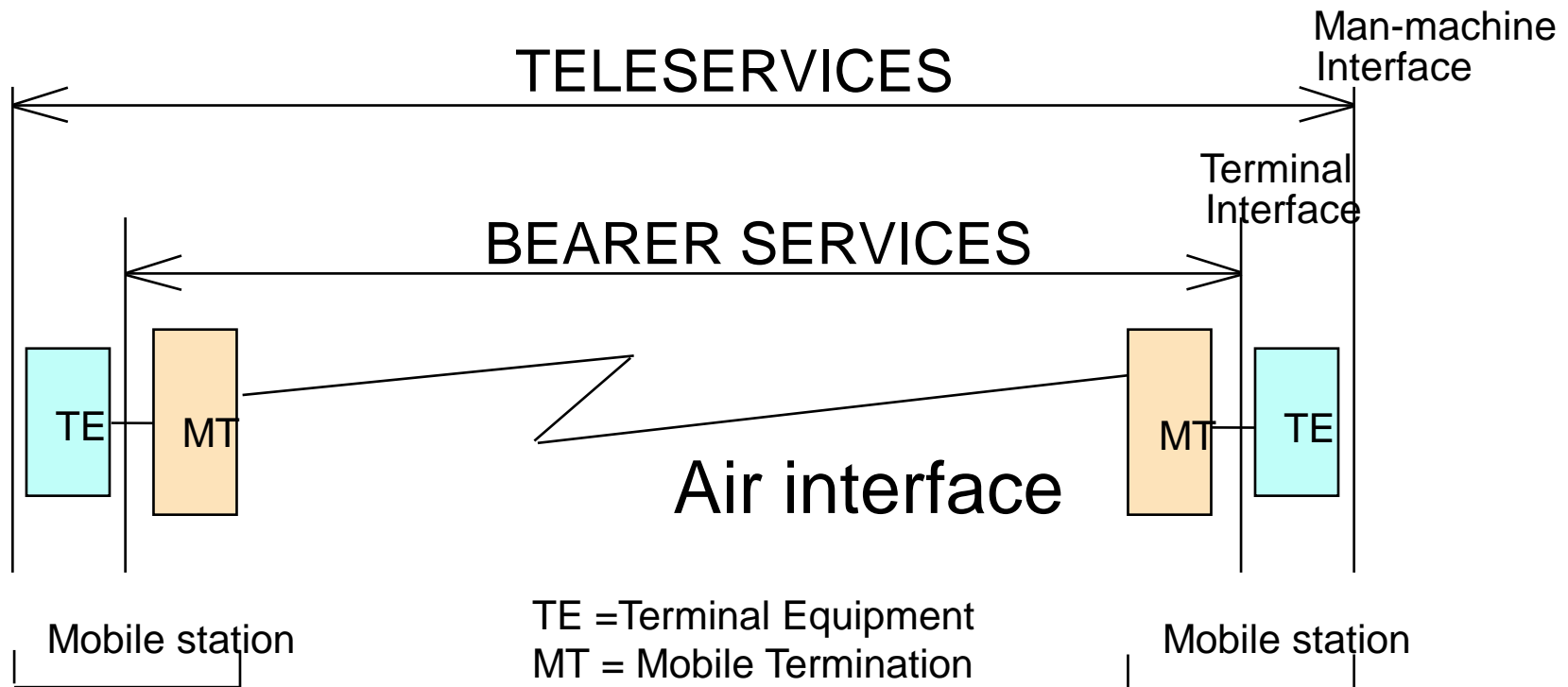
TETRA Voice + Data Services



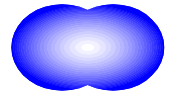
Tele Services & Bearer Services Supported by TETRA DMO



شاهین ارتباط تهران



Voice and Data (TRUNKING) service



شاهین ارتباط تهران

	Teleservice	Bearer service
TETRA speech	Individual Call (pt-to-pt) Group Call (pt-to-multipoint)	N/A
Circuit mode unprotected data	N/A	7,2 kbit/s (point-to-point) or (point-to-multipoint)
Circuit mode low protected data (one of three different interleaving schemes can be demanded).	N/A	4,8 kbit/s (point-to-point) 4,8 kbit/s (point-to-multipoint)
Circuit mode high protected data (one of three different interleaving schemes can be demanded).	N/A	2,4 kbit/s (point-to-point) 2,4 kbit/s (point-to-multipoint)
Short data service - type 1		16 bits user defined data
Short data service - type 2		32 bits user defined data
Short data service - type 3		64 bits user defined data
Short data service - type 4		2047 bits user defined data
Status messages		16 bits

TETRA Voice + Data Services



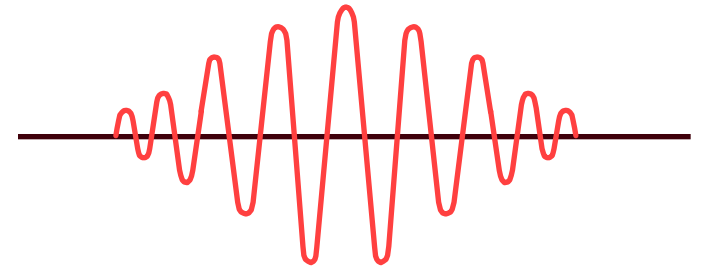
- **Bearer services:**

- Circuit mode data 7.2/14.4/21.6/28.8 kbit/s
- Circuit mode protected data 4.8/9.6/14.4/19.2 kbit/s
- Circuit mode heavily protected data 2.4/4.8/7.2/9.6 kbit/s
- Connection oriented packet data
- Connectionless packet data

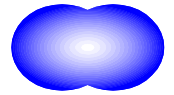
- **Teleservices:**

- Speech for individual call, group call, acknowledged group call, broadcast call

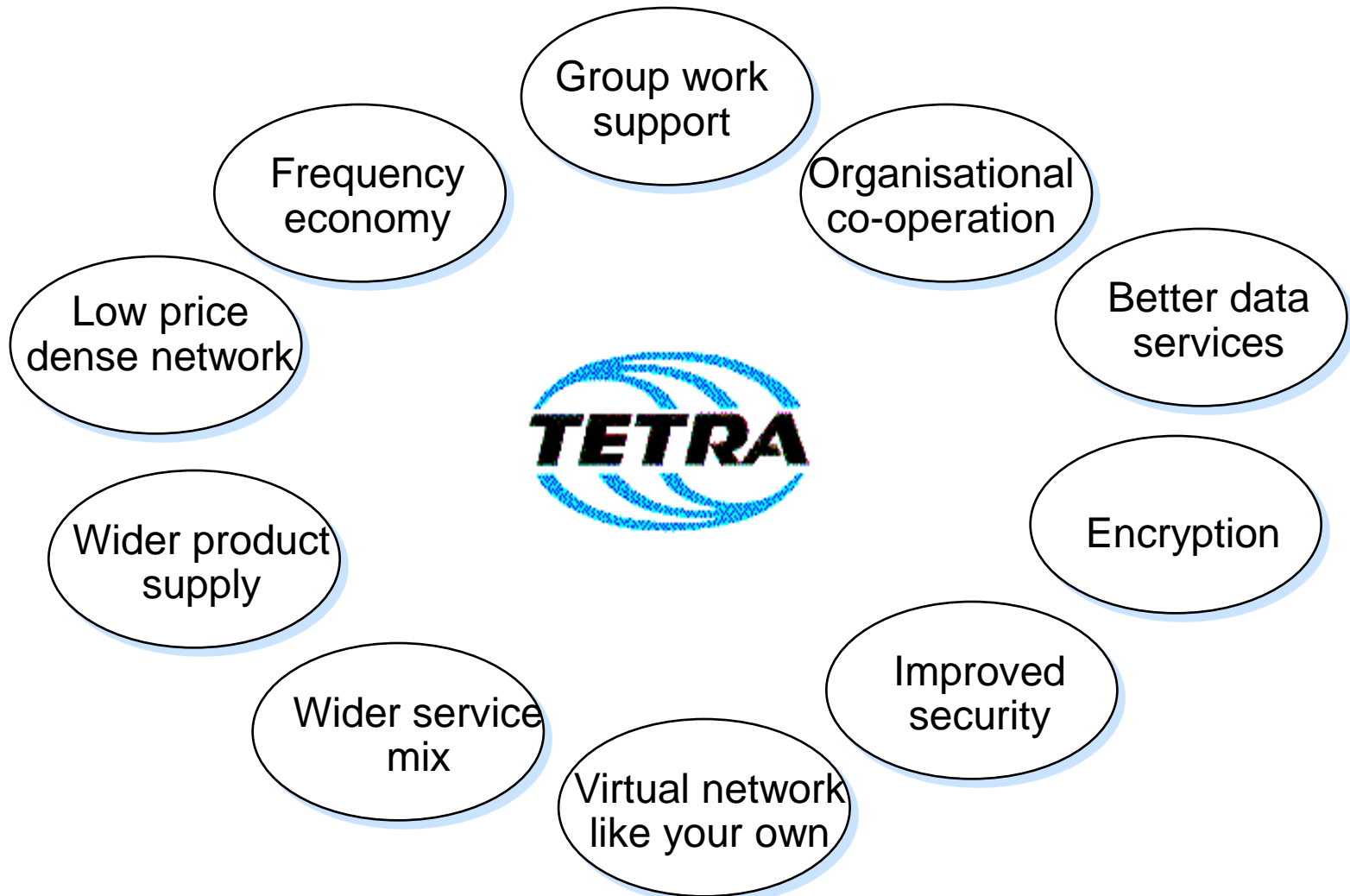
- **Status and short data messages**

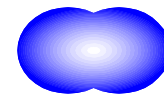


TETRA Opens New Opportunities

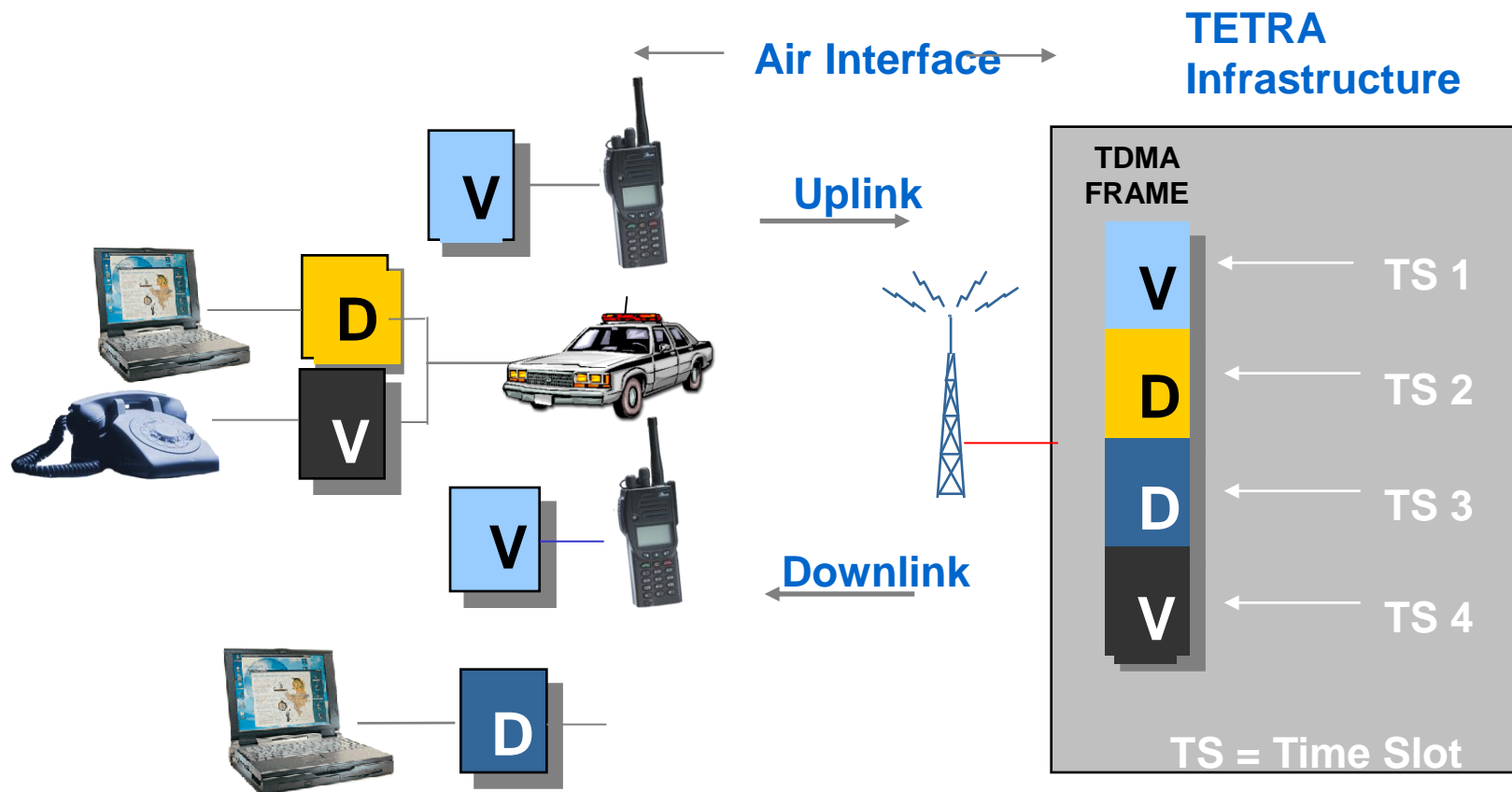


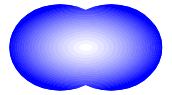
شاهین ارتباط تهران





TM V+D Air Interface





Safety

- High quality voice and data communication
- Immediate information to users in case of emergencies
- Personal safety features such as Emergency Call

Reliability

- Efficient and reliable dispatch operations for user groups
- Redundancy of critical components ensures high level of reliable communications
- Increased reliability of system means reduction of maintenance and repair costs

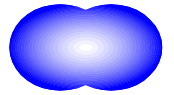
Performance

- High level of redundancy and resilience ensures reliable communication at all times
- Simplified procedures allows continuous optimisation of system resources
- High voice quality ensures that the message gets through – even in noisy environments

Ease of Operation

- Fast identification and correction of problems
- Enhanced capability to analyse traffic data

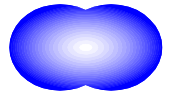
TETRA Data Trends



شاهین ارتباط تهران

- SDS and Packet Data benefits
 - Efficient transfer of data
 - Cost-effective since one channel is shared by many users
- Packet Data additional benefits
 - Ease of connectivity
 - Ease of development
 - Cost-effective IP-based equipment due to Internet explosion

BANDWIDTH ON DEMAND

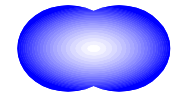


شاهین ارتباط تهران

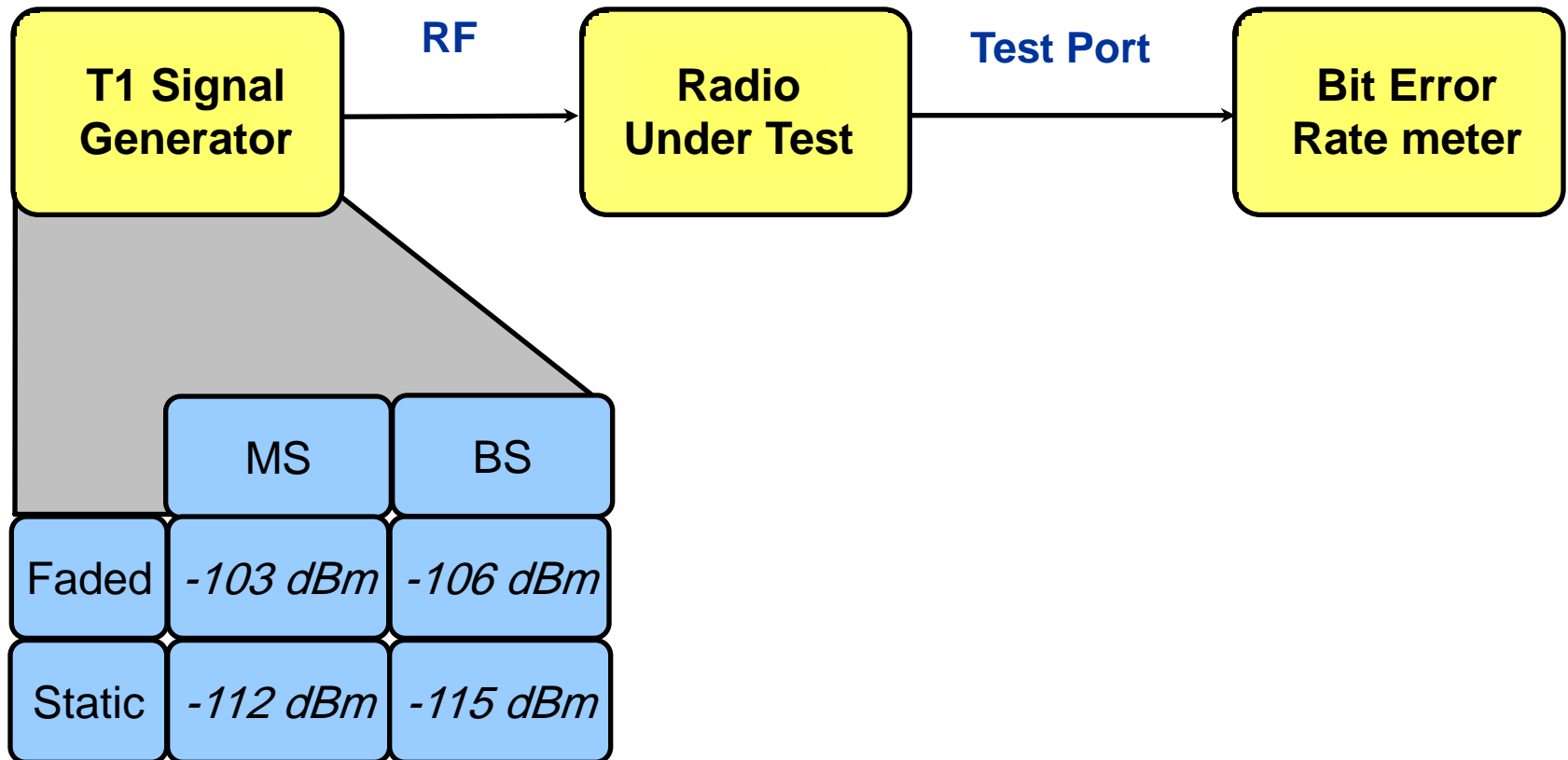
BANDWIDTH ON DEMAND

Number of Timeslots	1	2	3	4
No Protection	7.2	14.4	21.6	28.8
Low Protection	4.8	9.6	14.4	19.2
High Protection	2.4	4.8	7.2	9.6

Measuring sensitivity requires the use of BER measurements



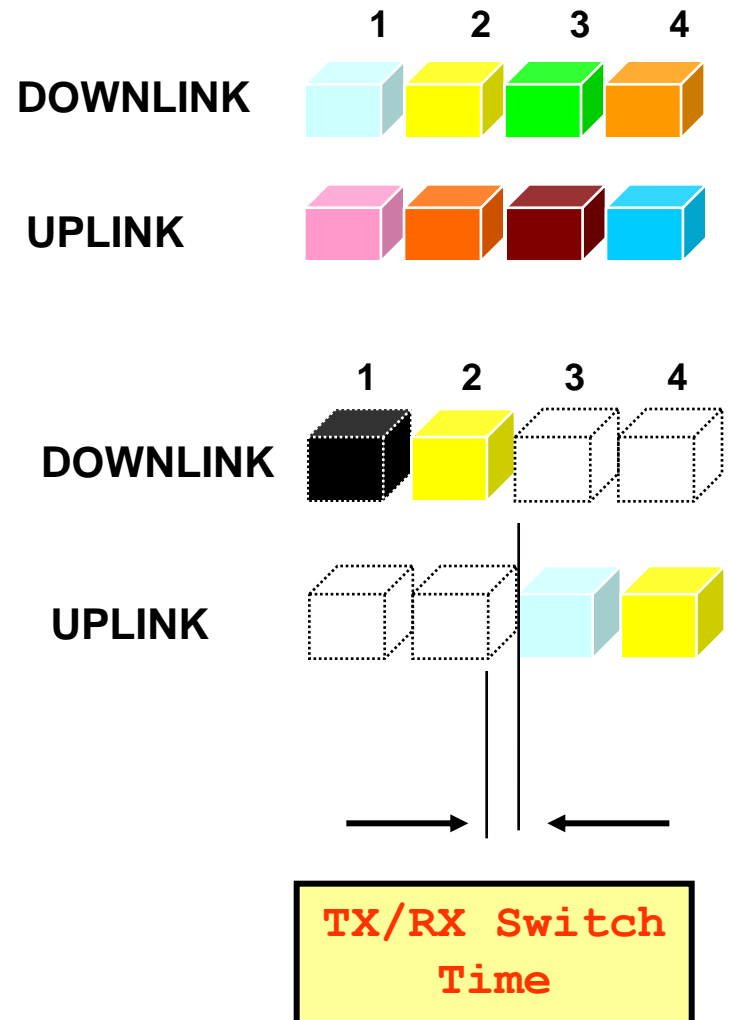
شاهین ارتباط تهران



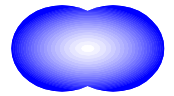
Symmetric Multi-slot Operation



- **Mobile** (generally full frequency duplex radio) hardware could allow operation in any combination of up to 4 slots (with terminal software and infrastructure support)
- Hand portable (half frequency duplex) requires 'Fast' switching
 - Switch between slots
 - Base station must allocate two consecutive slots
 - Heating issues and reduced battery life
 - Demonstrations of 4 slot downlink only operation

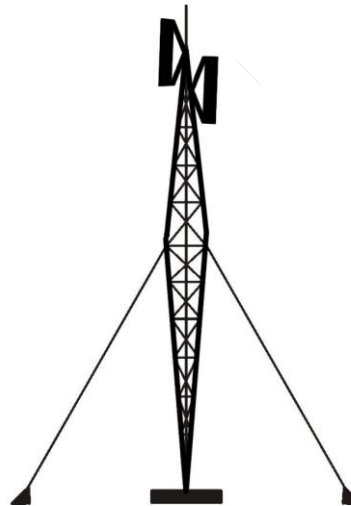


Set up a call to test the terminal - simplex ?

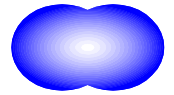


شاهین ارتباط تهران

- Simplex Calls
 - Mobile is either transmitting or receiving or quiescent
 - Group calls are always simplex, private calls may be simplex
 - Easy call set up but inconvenient for measurement analysis
 - **PTT** switch (Push To Talk) has to be held pressed
 - Talk time is usually limited, typically 1 minute maximum

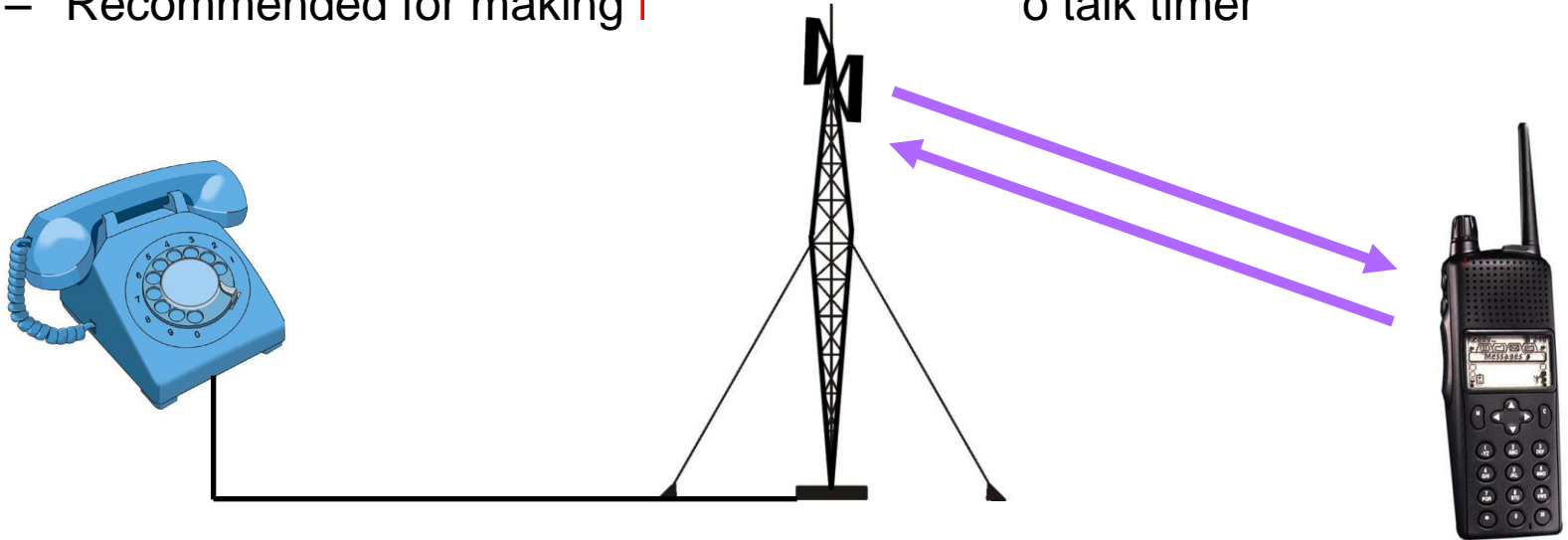


Duplex call recommended to test the terminal

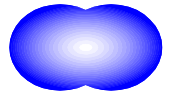


شاهین ارتباط تهران

- Duplex Calls e.g. Phone Call via PSTN Gateway
 - Select 'Phone Mode' or dial a number with leading digit '0'
 - Phone calls are usually but not always duplex
 - Mobile is transmitting and receiving (like GSM phone call)
 - Does not require holding PTT to continue transmission
 - Recommended for making **1** to talk timer

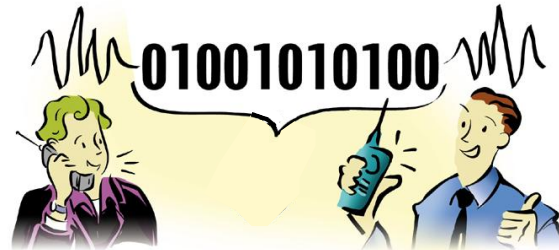


Interoperability

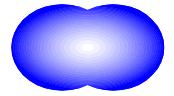


شاهین ارتباط تهران

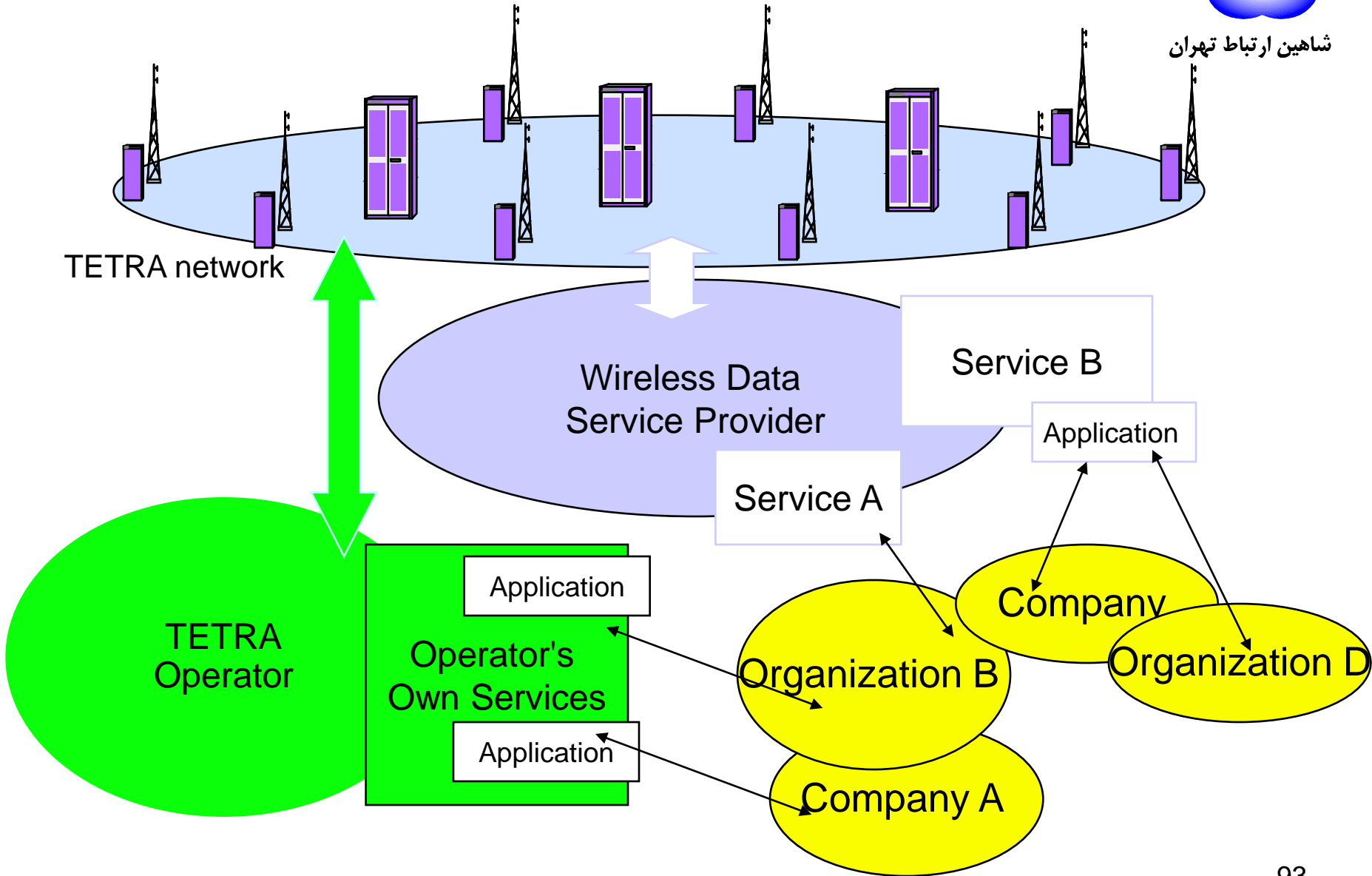
- The TETRA MoU interoperability (IOP) tests enable a multi-vendor situation where TETRA equipment from different manufacturers can work together.



New Business area: Data Service Providers



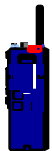
شاهین ارتباط تهران



TETRA Future Map

TERMINALS

TETRA R1 terminal



TETRA R1 terminal



R1+TAPS terminal



TAPS terminal

TETRA R1 terminal TETRA INTEGRATED TAPS R1+TAPS terminal
 TEDS TEDS & TAPS terminal ??

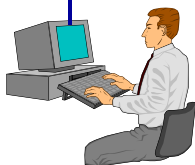


INFRASTRUCTURE

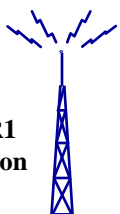
TETRA R1 Base Station



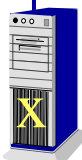
TETRA R1 Network



TETRA R1 Base Station



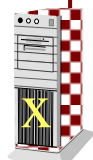
TETRA R1 Network



TETRA TAPS Base Station



TAPS Network



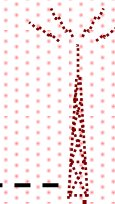
TETRA TEDS Base Station



TEDS Network



INTEGRATED TAPS Base Station



Integrated TAPS Network



TETRA R1 max. 28.8kbps

TETRA R2 Phase 1 TAPS max. 384 kbps

TETRA R2 Phase 2 28.8kbps < TEDS < 384 kbps

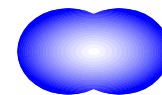
Appendix EPT WG1 (01)037

High Speed Packet Data



- Evolution of TETRA, which allows Packet Data at speeds more than 10 times that available in TETRA 1
- Two phased approach to meet conflicting market needs:
 - **TETRA Advanced Packet Service – TAPS**
To meet PAMR Operators' need for rapid deployment
 - **TETRA Enhanced Data Service - TEDS**
To meet need for backward compatibility

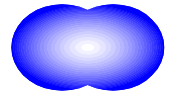
Characteristics of TETRA Systems



شاهین ارتباط تهران

- Fully digital
- Mixed voice and data communication
- Specified in open standards
- Makes efficient use of available spectrum (equivalent 6.25kHz channel occupancy)
- Allows internetworking with other communication networks via standard interfaces
- Extremely capable - supports a wide range of standard and supplementary communication services
- Integrated security (user/network authentication, air-interface encryption, end-to-end encryption)
- Supports wide area (inter-network) roaming
- Call handoff between cells

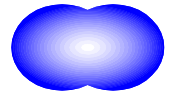
Characteristics of TETRA Systems



شاهین ارتباط تهران

- A platform for a wide variety of mobile communication applications Network size: Local, Regional, National, International
- Virtual network environment allows an organization share a common physical network with others yet maintain privacy and have full control over their own communications functions
- Short data can be sent or received simultaneously with an ongoing speech call
- Effectively supports group working. Can manage group memberships over the network
- TETRA capacity: over 16 million identities per network; over 16 thousand networks per country.
- Direct Mode Operation (DMO) permits communication between mobiles without the network. DMO supports repeater and gateway functions to increase coverage

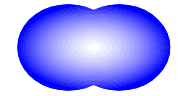
Characteristics of TETRA Systems



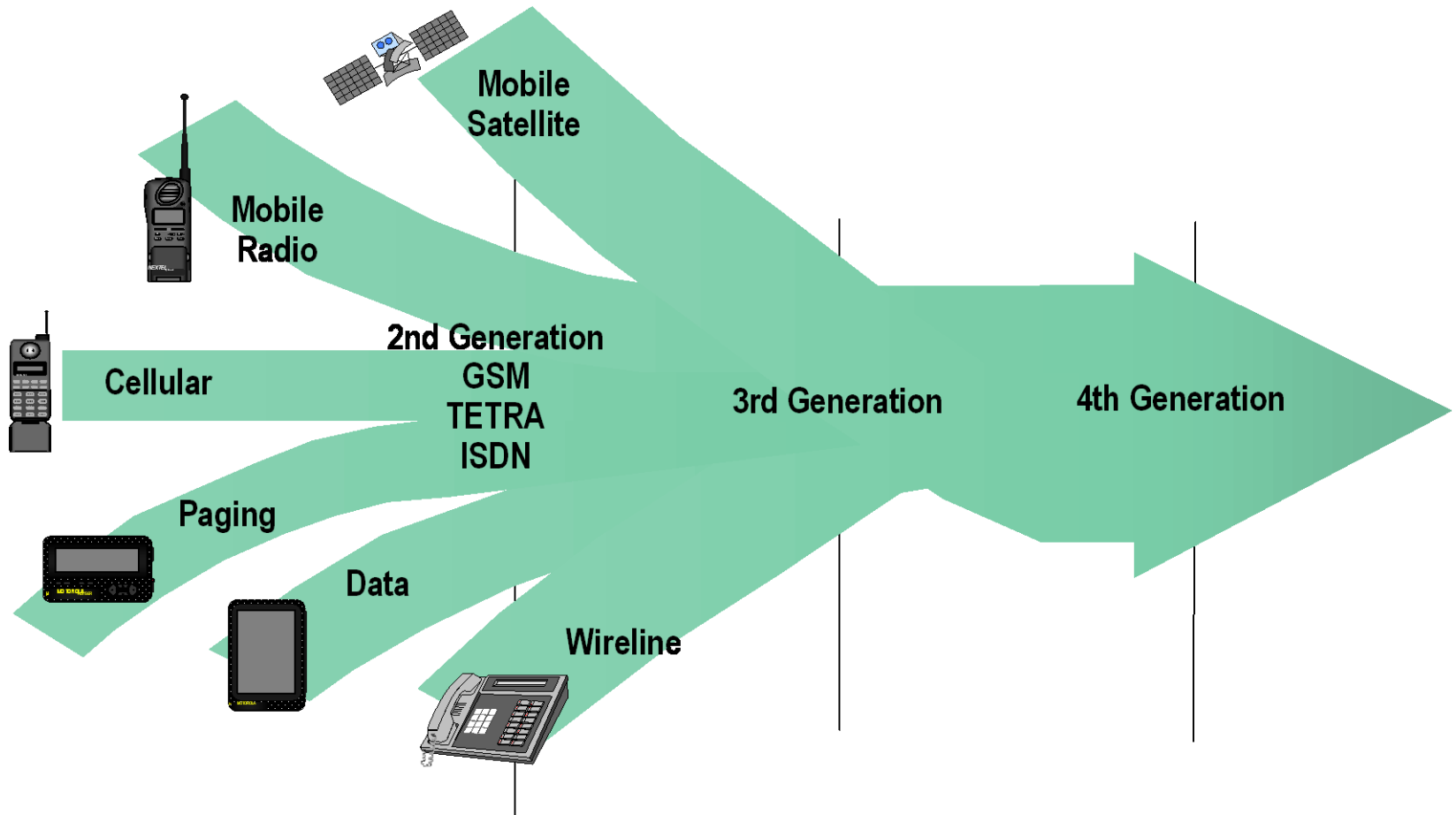
شاهین ارتباط تهران

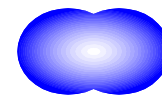
- Individual/group call setup time less than half a second (same cell)
- Priority mechanisms to guarantee access to the network
- Robust protocol designed to prevent crossed calls and other phenomenon resulting from unreliable propagation
- Independent allocation of uplinks and downlinks increases efficiency
- Network supports energy economy to improve mobile battery life
- Optional subscriber identity module (SIM card) for security keys and personal data
- User terminals may support multiple applications
- Bandwidth on-demand for increased efficiency

Plausible Prediction?



شاهین ارتباط تهران

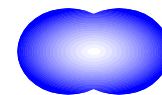




Conclusions

TETRA Architecture and Interfaces provide:

- Spectrally-efficient feature-rich communication
- Choice of trunked or direct modes
- Interoperability between different TETRA networks
- Use of circuit and packet mode switching and taking advantages of both technologies
- Multimedia services, Internet access and extensive data applications capability
- Inter-working with public networks
- Future proofing via an upgrade migration path to wide-band TEDS (TETRA Release 2) networks



شاهین ارتباط تهران

Thank You

خدا نگهدار

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Bahman 1385