Statewide EMS Operations and Communications

Resource Manual

State of California
Emergency Medical Services Authority

Statewide EMS Operations & Communications Resource Manual
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STATEWIDE EMS OPERATIONS AND COMMUNICATIONS RESOURCE MANUAL

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INTRODUCTION

PURPOSE

This Emergency Medical Services (EMS) Operations and Communications Resource Manual has been developed by the State of California Emergency Medical Services Authority (EMS Authority) primarily as an operational manual to be available to all local EMS agencies. It contains useful information for EMS operations, as well as provides the data necessary to enable radio communications during transport operations within the state.

The manual is also intended to be useful for instructional purposes in training programs for Emergency Medical Technicians (Basic, Intermediate, and Paramedics) through its operational approach and sections on radio frequency communications.

SUMMARY

The Operational Information section of this manual contains requirements of the Federal Communications Commission (FCC) rules relating to communications operations, information on standard operating practices, discussion of the various radio frequency bands, and an explanation of primary sources of interference which can disrupt normal communications, as well as a definition of the concepts involved in EMS communications.

The California EMS Allocations section contains an alphabetical listing, by local EMS agency, of all radio frequencies for EMS operations within the state, as well as hospital emergency department addresses, telephone information, and helipad coordinates. Radio dial codes are shown for those counties using selective addressing for radio communications with hospitals. In addition, the telephone number of each ground and air ambulance provider is included showing the quantity of ALS, BLS, and air transport permitted vehicles licensed to each. The most recent information added to this manual for each local agency are coordinates for commonly used helispots for ground to air transfers that may be designated as an emergency landing zone.

OPERATIONAL INFORMATION

FCC RULES AND REGULATIONS

The Federal Communications Commission (FCC) prescribes a framework of rules to govern the transmission of radio signals. Under these rules, each user of the radio spectrum must be eligible to operate on given frequencies and be authorized to do so. The FCC rules and regulations are organized into various parts and subparts which address the FCC's practice and procedure as well as the particulars of the radio services into which the frequency spectrum is allocated, including frequency assignment policy and operating requirements. Public Safety communications including the Special Emergency Radio Service is governed by Part 90 of the FCC Rules.

1. **General Requirements**.

   Licensees of radio systems have direct responsibility for the proper operation of each transmitter licensed. They must ensure that radios are used in accordance with the FCC rules and for purposes directly related to the particular activities for which they are licensed. Priority is to be given to communications involving the imminent safety of life and property, but licensees are required to keep transmission times to a minimum and employ efficient operating procedures to maximize the utilization of the frequency spectrum.

   With the exception of those frequencies assigned for the exclusive use of a licensee in the frequency bands 470-512 MHz and 806-824/851-869 MHz, frequency assignments are considered to be available on a shared basis only. All licensees, and applicants for new licenses, are required to cooperate in the selection and use of frequencies in order to reduce interference and make the most effective use of the authorized radio facilities.

   Licensees are required to take reasonable precautions to avoid causing harmful interference to other radio users. This includes monitoring the operating frequency for communications in progress and other such necessary measures to minimize the potential for interference.

2. **Station Identification**

   For public safety communications systems, each station or system of stations must be identified by the transmission of the assigned FCC call sign during each exchange of transmissions, or once every 30 minutes if operation is continuous. Identification must be made by voice in the English language or, alternatively, may be made by automatic means using the International Morse Code. In addition to the call sign, station or unit identifiers may be transmitted as necessary or desirable for system operation.

3. **Operator Requirements**

   No operator license or permit is required for the individual personnel operating radio equipment. Any person having the consent of the system licensee may provide authorized communications on behalf of the licensee. Cooperating users of other's radio systems should maintain a written agreement of use for such systems.

   The licensee will at all times exercise responsibility for operations and is expected to provide observation, servicing and maintenance as often as necessary to ensure compliance with all applicable rules. Operators should be trained initially and recurrently regarding the complex nature of EMS communication systems utilized, as well as those local systems granting and expecting access.

OPERATING PRACTICES

In the course of providing emergency health care to the public, many of the individual participants practicing in the EMS system are required to communicate with one another via two-way radio facilities. Good operator practice is essential to the effectiveness and efficiency of any public safety communications system. For EMS, good practice followed by EMTs/paramedics, dispatchers, physicians and emergency department nursing personnel relates directly to a reduction in response time which in turn saves lives, reduces further injuries and minimizes suffering.

1. Equipment Familiarization

A first step in proper communications techniques is a familiarization with the radio equipment to be used by the operator. There are many different brands and types of radio equipment items that EMS personnel will encounter in their work, and manufacturers are continually introducing new products which will always present new educational challenges. As a minimum, communications systems are comprised of mobile and portable radios, base/repeater stations and various radio control devices. Additionally, they may include more complex aspects such as telemetry, satellite receiver voting systems, vehicular repeaters and trunked operations.

EMS personnel should take sufficient time to learn the correct operation of each item of communications equipment that they use. They should fully investigate the various features of that equipment in order to maximize the extent to which the equipment assists in delivery of emergency services. Operators are encouraged to ask questions of their colleagues, equipment maintenance technicians and manufacturers' representatives to ensure understanding.

Most EMS radio systems provide the flexibility to communicate to various hospitals and dispatch centers via the use of selectable channels, tones, and codes. EMS personnel must understand the procedures for such selections which are normally based on patient destination, status, local area, or combination of similar factors. EMS providers should include quick-reference documentation for use by field personal that is designed to be utilized during emergent circumstances. Hospital providers should also keep similar reference materials readily available at their radio positions.

2. Communications Skills

The objective of radio communications in EMS is to convey information in a concise and accurate manner. The communications skills exhibited by operator personnel can have a positive influence on the outcome of a particular event.

A. Operating

For most EMS providers there is generally a protocol (written or unwritten) to govern radio communications. If unwritten, such procedures are probably defined by tradition. No attempt is made here to establish a particular mode of operation however; certain key points are highlighted for the benefit of operator personnel.

Follow standard protocol established by the EMS service. It may address the manner in which calls are to be placed from one unit of the service to another and govern the manner in which messages are formatted.

Maintain channel discipline. Courtesy and respect for the communications of others sharing the radio channel go a long way in preserving order, especially in congested geographic areas with much radio traffic. Monitor the channel before transmitting to prevent interference to other users. Think ahead and keep transmissions short and to the point to maximize airtime.

Practice verbal communications skills. Speak distinctly, at a moderate rate, and directly into the microphone or handset to maximize intelligibility. Keeping the microphone close to the mouth overcomes background noise and permits the operator to speak in a normal tone of voice. Shouting is to be avoided as it results in audio distortion.

Use plain language to describe a particular condition or event when in doubt of the appropriate aural brevity code which might otherwise be used. Individuals under stress may find it easier to relate clear and simple descriptions.

B. Technical Considerations

Key your transmitter before engaging in speech. The complexities in communications system design often introduce delay in the time it takes to turn on the various components comprising the system. Transmitters take time to come up to full power output, tone squelch decoding equipment requires time to open receivers and receiver voting systems take time to select the best receiver. While these events generally are accomplished in less than one second's time, there are many voice transmissions that could be missed in their entirety if the operator did not delay slightly before beginning his/her voice message. Pausing one second after depressing the push-to-talk button on the microphone or handset is sufficient in most cases to prevent missed words or responses.

Transmissions should generally be kept to less than 20 seconds, or within the time specifically allocated by the system. Most radio systems limit transmissions to less than 30 seconds to prevent malfunctioning transmitters or accidentally keyed microphones from dominating a system, and will automatically stop transmitting at the expiration of the allowed time cutting off additional audio.

Keep loudspeaker clear of clutter. Papers or other materials covering or obstructing loudspeakers can diminish receiver audio and alter intelligibility.

Avoid turning receiver volume too low. A low setting may fail to attract the operator's attention to an incoming call.

RADIO THEORY

1. Land Mobile Radio Frequency Bands

In the spectrum between 25 MHz and 1,000 MHz are various bands allocated by the FCC for two-way mobile radio communications known as land mobile radio bands. They have the following common designations:

25 – 50 MHz	VHF Low Band
150 – 174 MHz	VHF High Band
450 – 470 MHz	UHF Band
470 – 512 MHz	UHF TV Sharing (specific areas only) or "T" Band
806 – 824/851 – 869 MHz	800 MHz Band

Each of these frequency sub-bands are widely used for two-way land mobile radio communications in the Public Safety Radio Services. The choice as to which one is best for a particular operation depends on the frequency availability, the particular type of communications system required, the radio coverage area required, and many other engineering factors. Because of the consistently high demand for radio frequencies within the past few years, it usually becomes a matter of frequency availability rather than preference. However, when it is possible to choose the operating frequency of a radio system, the characteristics for each band should be carefully considered. Each frequency band has its unique properties which must be factored into the overall engineering of the system design for each user.

2. VHF Low Band

VHF Low Band has, as its advantage, the farthest coverage distance (other factors being equal) of any of the land mobile frequency bands. Given the same operating conditions (transmitter power and antenna height) low band will generally "talk" farther base-to-mobile and mobile-to-mobile. It is also better suited for traversing hilly terrain and penetrating heavily wooded areas than higher frequencies.

Unfortunately, VHF Low Band has several disadvantages not shared by higher frequencies. It is commonly affected by skip interference (which occurs when radio signals are reflected from the upper atmosphere at great distances from the location of origin). It is not uncommon to receive stations over 2,000 miles away, and such occurrences tend to disrupt local communications. VHF Low Band is also affected to more of an extent by man-made noise sources than higher frequencies. Automobile ignition systems, motors, commercial power lines and electric fences in the vicinity of radio receivers may create so much electrical noise that the desired radio signals may be masked at times to the point that they become unusable.

Additionally, and for some of the above reasons, VHF Low Band does not generally fare well in urban environments. In addition to the above shortcomings, antennas for

VHF Low Band communications must be relatively large compared to higher frequency antennas; attempts to shorten these antennas for convenience or practicality results in inefficiency and reduced coverage area.

3. VHF High Band

Within the 150 MHz range of VHF High Band, skip interference is considerably reduced. Manmade noise sources also are not of as much concern, and better penetration into metropolitan area environments is realized. Due to the shorter wavelength of VHF High Band, it becomes practical to use shorter antennas that exhibit greater gain than with similar lengths at VHF Low Band.

VHF High Band has typically been, for the above reasons, the band of choice for many applications. In many parts of the United States, however, VHF High Band has become so congested, particularly in metropolitan areas, that interference of several kinds from neighboring systems is often received. Point-to-point co-channel interference is particularly severe in view of the simplex-type allocation of these frequencies by the FCC. VHF High Band is also characterized by a somewhat shorter communications range than VHF Low Band, especially on a mobile-to-mobile basis.

4. UHF BAND

UHF Band communications are virtually free from skip interference and electrical noise when compared to lower bands. At 450 MHz, the radio waves are physically shorter than VHF Low Band or High Band such that they have an ability to easily reflect off of common hard surfaces. Thus, the UHF Band is often an excellent choice for penetrating into, and around, heavy building structures in urban areas.

As frequency is increased however, losses due to hills and foliage also increase. The UHF Band has more difficulty transmitting signals over hilly or irregular terrain than with lower bands. Hills tend to block the signal more severely and can significantly reduce range. Also, absorption of the signal by trees and other foliage is more prevalent at UHF and must be factored into any UHF system design. Since mobile-to-mobile range is significantly less than that accommodated by the lower frequency bands, repeater stations are commonly used to relay transmissions between mobile units.

Most EMS systems utilize the Emergency Medical Service UHF MED channels within this band.

5. 700 MHz Band

Until recently, the FCC has licensed most of the 700 MHz spectrum to television broadcasters for analog television. This spectrum was deemed desirable for both broadband communications in general and public-safety uses due to the unique propagation characteristics of this band and the fact that many urban areas currently use the 800MHz band. This spectrum is divided into two bands -- the lower and upper 700 MHz. The lower band is 48 MHz wide, and the upper band is 60 MHz wide. Of the upper 60 MHz, 24 MHz is reserved for public safety use since this portion of the spectrum is contiguous with the existing 800 MHz band already in use by public safety. The FCC auctioned large portions of the lower 700 MHz band to commercial carriers who will use the spectrum for broadband applications, while the upper 700 MHz band is divided in to several sub-bands. Public Safety will use the upper-most band of the 700 MHz while the adjacent “D block” band will be auctioned by the FCC in an effort to create a Public / Private partnership which will operate a nationwide broadband network, with priority access granted to public safety.

The lower a radio signal's frequency, the farther it can propagate provided that no objects obstruct its paths. Conversely, the higher a frequency, the more easily it can penetrate dense obstacles like walls and buildings. Higher frequencies also tend to be used to support trunked radio systems and high speed data networks which are more efficiently utilize the spectrum, enabling radios to transmit more data for each hertz of frequency band. As a result, the 700-MHz band should provide better coverage in urban areas for public safety when used to support a properly designed and implemented system than current cellular bands do.

6. 800 MHz Band

The characteristics of the 800 MHz Band are very similar to the UHF Band except that the negative aspects are somewhat accentuated. With the proper engineering and design however, the 800 MHz Band can be a viable alternative to the lower frequencies. Beyond any question it is currently the one band for which the latest communications technology is offered. It is also the only land mobile frequency band that (at least today) is generally less congested than lower bands. In many areas of the United States, including areas of California, the 800 MHz Band is the only band in which new channel assignments are currently available. EMS units utilizing 800 MHz systems are typically affiliated with a local agency hosting such systems. These systems are usually based on a complex trunked radio network. The trunked system administrator must grant access to and normally provides and/or maintains equipment of the local EMS providers to access these systems.

RADIO FREQUENCY INTERFERENCE

The ability to communicate by radio may be significantly affected by other communications systems operating on the same or different frequencies. Most interference that occurs is unintentional and can be difficult to identify if it can be detected at all.

1. Co-Channel Interference

This type of interference is most readily identified and occurs from different radio systems sharing the same frequency. Ideally, systems are authorized with sufficient geographic distance between them such that one system does not hear the other system and vice-versa. On occasion, however, atmospheric conditions will support better than normal communications range and audible signals of the distant system are received. Depending on the strength of these co-channel signals, normal communications may be disrupted or precluded. Co-channel interference will result on shared radio channels, such as the UHF MED channels, unless careful coordination of frequency assignment and usage is ensured.

2. Receiver Desensitization

When using a radio receiver in the physical vicinity of a transmitter operating on a frequency close to that which the receiver is tuned (but not directly on it), the receiver's ability to hear weak on-channel signals is impaired. The effect may be to lose a desired transmission completely or it may appear to be partially cut off.

3. Transmitter Noise

Transmitters are not perfect devices and will radiate some amount of noise in addition to the primary signal. This noise appears on either side of the transmitted signal and can interfere with nearby receivers tuned to other frequencies. The end result is similar to what is experienced with receiver desensitization, but the mechanism of interference is masking of desired signals by the noisy transmitter.

4. Intermodulation Interference

Inter-modulation interference, or "inter-mod", is caused when two or more radio signals of different frequencies combine to create yet other frequencies (a process known as mixing). If one of the new frequencies produced happens to occur on a desired receiver frequency, interference may result to desired signals. Such frequency mixing often occurs either in a transmitter or a receiver.

Transmitter-produced inter-mod occurs when strong radio signals are combined in the power amplifier of a transmitter, and the mix frequencies are re-radiated along with the intended signal. If one of the mix frequencies is heard in the affected receiver, it may be possible to detect the audio of the interfering signal as comprised of multiple voices in accordance with the number of transmitters participating in the mix.

Receiver-produced intermod manifests itself when two or more strong off-frequency signals combine in the receiver electronic circuitry to create still other frequencies through mixing. Like the transmitter-produced case, if one of the resultant frequencies is nearly the same as the frequency to which the receiver is tuned, the inter-mod signal will compete with the desired received signal.

Inter-modulation interference can generally be identified by listening to the interfering signal, because it will usually be comprised of two or more voices and is likely to suddenly cease when one of the transmitters contributing to the mixing process is turned off. However, the process of identifying the participants so as to remedy the interference problem may not be so easy since they may be located at other radio sites and operate in different radio services. Additionally, inter-mod is produced in sites other than transmitters and receivers. These sites of production may include antennas, metallic flashing on rooftops, rusted or corroded mechanical joints of antenna towers, and on occasion, rusted automobile bodies or similar materials.

5. Equipment and Interference Rejection

While the occurrence of interference in the radio environment cannot be totally eliminated, it can often be controlled to the point where its harmful effects minimize the disruption of communications. For the public safety services, the purchase of communications equipment exhibiting quality in the design of interference rejection circuitry will do much for dealing with the problems of receiver desensitization, transmitter noise and inter-modulation interference. Additionally, proper system engineering is required to provide for ancillary protective devices (such as radio frequency filters and isolators) where needed.

CONCEPTS OF EMS COMMUNICATIONS

1. General

An EMS communications system must provide the means by which emergency medical resources can be accessed, mobilized, managed, and coordinated in both normal and adverse situations. An EMS communications system must therefore, employ sufficient communications paths and operational capabilities among all participants to facilitate the functional EMS communications concepts described in the remainder of this section.

2. Citizen Access

The EMS communications system must have the ability to receive and process any incoming requests that report emergencies and require emergency medical assistance. All individuals shall be able to summon help rapidly in an emergency situation whether for medical, police, fire, rescue, or other emergency need. Local, statewide, and national uniformity is required to fully enable this concept.

The State of California 9-1-1 Plan provides for a cohesive statewide emergency telephone number system to provide citizens with this rapid direct access to public safety agencies.

3. Vehicle Dispatch and Response (VDR)

On notification of need for emergency medical assistance, the communications system must enable prompt dispatch of EMS vehicles (including notification of rotor-wing aircraft) to the location of the emergency. The communications system must further enable dispatchers to communicate with responding vehicles while in route to the scene, while at the scene, while in route to hospital emergency department facilities, and during their return to availability for further assignment.

4. Automatic Vehicle Location

Use of automatic vehicle location (AVL) systems provide real-time geographic location of vehicles to ensure the nearest available vehicle is dispatched to the scene of an incident. Additionally, an AVL system displays vehicle positions to dispatchers on either tabular and/or graphic displays as well as providing the information necessary to a computer-aided dispatch (CAD) program when utilized in a system status management structure.

5. Crew Alert Paging

As a sub concept to vehicle dispatch and response some EMS communications systems, as determined by local procedure, may require the direct alerting of EMS personnel either individually or in groups, through the use of either monitor or paging receivers, station public address system, or by means of two-way handheld portable radios with a selective call capability. Crew alert paging may also include call-specific information via digital pager or paper printout.

6. Local Medical Coordination (LMC)

The EMS communications system must provide EMS field personnel with a channel of communications that permits the exchange of vital information between both EMS field personnel and emergency department personnel while the patient is at the scene of the medical emergency and while being transported to an emergency department facility. Typical LMC communications involve patient status and destination, as well as information permitting or requesting medical control decisions regarding patient care.

7. Statewide Medical Coordination (SMC)

In addition to LMC capability, the EMS communications system must provide a communications channel to enable medical coordination between EMS field personnel and emergency department personnel during situations in which a vehicle is out of its prime area and unable to access an emergency department using their assigned LMC channels, or in isolated critical situations during which prolonged use of the LMC channel would not be feasible due to other LMC communications traffic. Such uses of the SMC channel would typically occur for temporary durations.

8. On-Scene Coordination (OSC)

The EMS communications system must have the capability for mobile and portable radios to communicate directly (unit-to-unit) while on the scene of an emergency requiring multiple vehicle and multi-agency responses. Typically this coordination takes place either on VHF high band interoperability channels, or on channels maintained by the local rescue agencies involved.

9. Medical Resource Coordination (MRC)

The EMS communications system must allow for point-to-point coordination of EMS resources between hospitals, providers, and communications control centers for response to a disaster or mass casualty incident. Telephone lines between communications control centers are typically used for resource coordination during normal operations, and networked software specifically for this use is becoming more prevalent. However, radio communications are needed during situations following hurricanes, tornadoes, floods, fires, etc., when telephone lines are inoperative, or when telephone central office switching facilities are jammed or disabled. Most EMS agencies and hospitals maintain some functionality of the HEAR network VHF high band frequencies for this purpose.

CALIFORNIA EMS ALLOCATIONS

GENERAL

The following tables of radio channels and allocations and organizational data for EMS communications within California was a major undertaking by the State of California. The effort began in 1997 with a survey of all counties, EMS providers, and hospitals in the State. That survey was followed by numerous site visits, mail surveys and telephone inquiries continuing through the fall of 1998. In October 2008, revision efforts began by requesting that each local agency representative review data relating to its respective area(s) and submit any corrections or changes to the previously submitted information. Every effort has been made to ensure the data collected is as accurate, complete, and up-to-date as possible. If errors are identified, please advise the EMS Authority.

INTRODUCTION TO TABLES

Note: In the following tables the symbol N/A = Not Available and N/R = No Response

The following tables are organized alphabetically by the local EMS agency. Within each local EMS agency is a list of radio channel information, followed by information on emergency department facilities, and EMS providers.

1. Radio Channel Information

Radio channel information is shown by channel use description, by continuous tone controlled squelch (CTCSS) frequency (in Hertz), by primary or alternate status, and by base-transmit and base-receive frequency in (MHz or MED channel number).

A. MED Channel Frequencies

MED Channel numbers 1 through 103 are prescribed by FCC Rules, Part 90.27(c)(13)(i) and 90.27(b) as corresponding to the following radio transmit frequencies in MHz:

MED Channel	Frequency (Base/Mobile)	Frequency (Mobile Only)
1	463.000	468.000
2	463.025	468.025
3	463.050	468.050
4	463.075	468.075
5	463.100	468.100
6	463.125	468.125
7	463.150	468.150
8	463.175	468.175
9	462.950	467.950

10	462.975	467.975

B. CTCSS Frequencies

Continuous Tone-Controlled Squelch (CTCSS) systems provide a reduction of nuisance interference in FM radio systems by incorporating a sub-audible tone onto the radio carrier information such that only a similarly equipped radio receiver will open its squelch circuit to receive the transmission. Systems equipped with CTCSS will eliminate much interference from distant sources, although CTCSS by itself cannot prevent undesired “FM capture” from occurring due to nearby simultaneous co-channel transmissions.

CTCSS frequencies are designated by the Electronic/Telecommunications Industries Association (EIA/TIA) in EIA/TIA Standard 603. The following table is a portion of those CTCSS frequencies above 90 Hz and below 211 Hz which are approved for EMS radio communications in California. Since there is an abbreviated code scheme for these frequencies common to systems supplied by Motorola Communications & Electronics Inc., the Motorola (MOT.) code designations of these CTCSS frequencies are also shown. Similarly, the Wolfsberg (WOLF.) codes are also shown. To the extent possible, CTCSS tones within a local geographic area should be exclusively from either Group A or Group B to avoid false sensing due to adjacent tone frequencies.

Group A

CTCSS Freq.(Hz)	MOT. Code	WOLF Code
100.0	1Z	14
107.2	1B	16
114.8	2A	18
123.0	3Z	22
131.8	3B	24
141.3	4A	26
151.4	5Z	28
162.2	5B	32
173.8	6A	34
186.2	7Z	36
203.5	M1	38

Group B

CTCSS Freq.(Hz)	MOT. Code	WOLF Code
94.8	ZA	12
103.5	1A	15
110.9	2Z	17
127.3	3A	23
136.5	4Z	25

146.2	4B	27
156.7	5A	31
167.9	6Z	33
192.8	7A	37
210.7	M2	-
210.7	M2	

Excluded from the above list are:

CTCSS frequencies below 90 Hz which may cause unacceptably long receiver response times in some systems; frequencies above 211 Hz which may require special engineering considerations in production; frequencies which would receive interference from common 60 Hz AC power systems; and non-EIA frequencies offered by some manufacturers which would limit intersystem and mutual-aid operations.

C. Primary/Alternate Allocations

The primary and alternate designations on some MED Channels shown on the following tables derive originally from FCC rules requiring not less than four channels (three, if bio-medical telemetry is not employed) be provided from EMS base station operations for medical coordination between ambulances and hospital emergency departments. The primary/alternate scheme of allocation is necessary to insure that a channel is available when needed considering simultaneous MED Channel use in adjacent areas.

2. Emergency Department Information

For each local EMS agency, emergency department facilities are listed with their address followed by the 24-hour telephone number of either the switchboard (Main), emergency department (ED) or both.

3. EMS Provider

Within each local EMS agency, EMS providers are listed alphabetically showing the type of transportation (ground [G], air [A], water [W]) quantity of ambulances, whether or not the vehicles transport to a hospital and the highest level of Advanced Life Support (ALS) or Basic Life Support (BLS) certification at the location. The telephone number of each provider is also shown.