



City of Phoenix

Phoenix Fire Department  
Radio System Safety Project

Technical Team  
Requirements Definition #27  
Final Draft

June 10, 2005

# Phoenix Fire Department Radio System Safety Project

## **Executive Summary**

The Phoenix Regional Wireless Network (PRWN) is a “trunked” or shared radio system designed to provide efficient, wide area public safety wireless communications across the greater Phoenix metropolitan area. PRWN uses a complex network of computer controllers and a fixed location radio infrastructure that relays or repeats messages to provide nearly instantaneous radio communications to large groups of users simultaneously, regardless of location in the coverage area. While designed as a robust architecture, the sophistication of the PRWN control structure that provides the trunked wide area operation complicates communications for local area, on-scene, emergency response.

For example, in typical firefighting situations, once an operational area is defined by the initial emergency responder(s), the need for wide area operations to other radio users greatly diminishes for the individuals involved in the immediate, emergency tactical response. These local area or on-scene incident operations need a functionally simple and operationally predictable communications system to support emergency service providers. Reliable communications are critical to the safety of the units for any fire department response that involves hot zone operations or other hazardous emergency conditions.

In support of the PRWN design process, the Phoenix Fire Department conducted an extensive study to determine the most appropriate radio communications technology for use during incident operations. The study used a qualitative assessment process to analyze different technical options using actual firefighting scenarios. The testing options included the PRWN trunked system, analog simplex operation, and digital simplex operation. All modes of operation used the various frequency bands available for public safety operations. Ultimately, the department collected and analyzed data from over thirty different locations. These locations included the four different types of buildings that are defined by the National Fire Protection Association as appropriate for the Phoenix area.

The Fire Department study concludes with a recommendation to use 700/800 MHz, simplex channels with analog modulation for firefighting operations. The simplex channels provide reliable and consistent communications that are not dependant on the PRWN infrastructure for communications between those units directly involved in the incident. The study further recommends additional equipment for the necessary radio communications between the Fire Department Alarm Room (dispatch center) and the incident units operating on the fire ground.

As a result of the study’s recommendations, the Information Technology Department, Motorola, and Buford Goff & Associates assisted the Fire Department in completing a formal radio communications needs assessment for incident operations. These defined requirements are designed to support the next phase of the Fire Department’s transition to PRWN by providing the functional and technical requirements for a conceptual design to support safety enhancements to the PRWN system for on-scene incident operations.

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**Requirements High Level Outline**

<b>Unique Functional Requirements</b>	<b>Technical Solution Options</b>
On Scene Incident Analog Simplex Communications	Analog Simplex Channels *#^
Alarm Room Communications with the Incident Units	Remote Base Station Sites or Vehicular Repeaters *#^
Initial Dispatch, Incident Functional Support, and Non-Critical Communications uses the PRWN Trunking System	PRWN – Complete. Capabilities needed in expanded service areas. #^
Intra-Discipline and Interoperability with-Law Enforcement	Expand PRWN or Radio Station Patching using Console Functionality. *#^
Communications Continuity (Redundancy)	Consideration for Future Design. PRWN Redundancy and Control Station Backup - Complete.
Alarm Room Indicators (Status and Capacity)	Custom Solution, CAD Interface or 24 Hour Network Operations ^

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**1.0 Functional Requirements**

1.1. General Operations

- 1.1.1. To provide uninterrupted communications on the fire ground in a contaminated atmosphere for 1) radio unit to radio unit (Crew to Crew operations), 2) radio unit (Crew) to Incident Commander, and 3) On-scene incident radio units (Crew and Incident Commander) to and from the PFD Alarm Room location.
- 1.1.2. Radio unit to radio unit communications at all times, without changing channels.
- 1.1.3. No existing PFD operating procedures need to be changed.

1.2. Hot Zone Operations

- 1.2.1. Provide immediate, predominately local (simplex direct channel), radio to radio (Crew to Crew) communications (bi-directional) without changing channels. Supports tasks assignment, emergency traffic, Mayday signals, and status reports. \*
- 1.2.2. Crews operating radios in a contaminated atmosphere, breathing from Self Contained Breathing Apparatus (SCBAs), will be required to use the simplex radio channels. \*

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- 1.2.3. All radio units operating in the hot zone must be equipped with a PTT ID signaling feature. \*
- 1.2.4. All radio units operating in the hot zone must be equipped to receive an emergency traffic tone generated by the PFD Alarm Room. \*

### 1.3. On-Scene Incident Operations (Fire Ground)

- 1.3.1. Provides immediate critical, predominately local (simplex direct channel), Crew to Incident Commander communications (bi-directional). Supports tasks assignments, status reports, Crew accountability, and emergency response. \*
- 1.3.2. Provides wide area type operation (using the PRWN trunked duplex system) for non-critical functional support for 1) staging, 2) logistics, 3) rehabilitation, and 4) investigations. Incident Commander needs to be equipped for this type of operation.

### 1.4. PFD Alarm Room (Dispatch Center)

- 1.4.1. Provides wide area type operation to link the PFD Alarm Room to “all” Hot Zone and On-Scene Incident critical communications (simplex direct channel traffic). Supports reporting from Incident Command (tactical benchmarks) and command backup, notification to Incident Command of elapsed time and available resources, monitoring and recording of radio traffic, and monitoring of emergency and Mayday traffic. \*
- 1.4.2. Fire Call (Potential Hot Zone) - The Alarm Room will initially dispatch the call information using the PRWN trunked duplex system. The initial call will include the assigned tactical, critical (simplex direct) channel assignments. All further incident communications with the Alarm Room dispatcher (both transmit and receive) will occur on the assigned tactical (simplex direct) channels manned by a Tactical Radio Operator (TRO). \*
- 1.4.3. Critical radio traffic with the Alarm Room (talk-in and talk-out) from the incident should be balanced to ensure consistent communications with units.\*
- 1.4.4. On dispatch, responding units would be assigned a PRWN trunked talkgroup(s) or tactical simplex direct channel(s) based on the nature code of the call. On larger incident(s), functions on the fire ground will be classified as critical (C) or non-critical (NC). Critical functions will be assigned a tactical simplex direct channel(s) and non-critical will be assigned PRWN trunked talkgroups. \*
- 1.4.5. Initial Incident Reporting – Provide a mechanism for the initial crew arriving at an incident to immediately report the incident situation to the Alarm Room. \*
- 1.4.6. Alerting Tones – Provide a mechanism for the Alarm Room to generate alerting tones that will be received by all units (Crews) operating on the tactical critical simplex channels.
- 1.4.7. EMS Call (Non Hot Zone) - The Alarm Room will initially dispatch the EMS call information using the PRWN trunked duplex system. The initial EMS call will include the assigned tactical non-critical trunked system talkgroup assignments. All further non-critical communications with the Alarm Room dispatcher (both transmit and receive) will occur on the assigned trunked talkgroup manned by a Tactical Radio Operator (TRO).

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- 1.4.8. Connectivity – The Alarm Room must have continuity of communications regardless of system status. This requirement for redundancy includes the PRWN trunked duplex network and the simplex direct network. \*
- 1.4.9. Status Display – Provide a monitoring system that gives dispatchers a visual indication of the PRWN “System Status” (Green - Normal, Yellow – Site Trunking Somewhere, Red – Outage Somewhere). Dispatchers need immediate information related to any outage to allow determination of operational impact to fire services. All service affecting situations for the trunked duplex and simplex direct networks should be immediately reported to the Alarm Room. \*
- 1.4.10. Capacity Indicator – Provide an indication for the dispatchers of system capacity remaining as available for use. Also provide a “busy” indication when a certain level of capacity remains. Includes capacity (GOS) for the PRWN trunked duplex network and availability (location) for the simplex direct networks. \*

### 1.5. Special Operations

- 1.5.1. Other special operations in support of fire scene operations, such as use and coordination of a helicopter, may require the use of the simplex direct channels for use on an incident response as assigned for use by the Alarm Room during the dispatch process. \*
- 1.5.2. Secure communications will be a function of using an appropriate encrypted talkgroup from the PRWN trunked duplex network.

### 1.6. Intra-Discipline Operability

- 1.6.1. PRWN Fire Service entities require radio operability with other regional fire services that operate using non-PRWN radio communications systems (i.e. – Scottsdale, Buckeye, Gila River or State land). This is an intra-discipline requirement to support mutual aid operations. ^

## 2.0 Technical Performance

### 2.1. Analog Modulation

- 2.1.1. All hot zone and critical on-scene incident tactical radio transmissions will use a simplex analog transmission mode. \*#

### 2.2. Coverage Area

- 2.2.1. Primary coverage areas are within the legal boundaries of Phoenix, Glendale, Tempe, Scottsdale, Peoria, Laveen, El Mirage, Surprise, Sun City, Daisy Mountain, Youngtown, Sun City West, Tolleson, Guadalupe, Goodyear, Sun Lakes Avondale, and Chandler. \*#

- 2.2.2. Secondary expansion areas are the city limits of the Town of Buckeye. ^

### 2.3. Coverage Performance (for the coverage areas defined in Section 2.2)

- 2.3.1. Coverage performance defined for Hot Zone and On-Scene Incident critical communications for 1) radio unit to radio unit (Crew to Crew operations), and 2) radio unit (Crew) to Incident Commander is defined as the use of portable radios,

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operating on 700 / 800 MHz frequencies and using the simplex analog communications mode. \*#

- 2.3.2. Coverage for On-Scene Incident critical communication for radio units (Crew and Incident Commander) using the simplex analog communications mode with the PFD Alarm Room location is defined as the following: equivalent to DAQ 3.4 / 95% area reliability for portable in-building communications (talk-out from the portable to the Alarm Room and talk-in from the Alarm Room to the portable), in the presence noise, interference and other factors as listed in TIA/EIA TSB-88, using the following margins above those required for the defined area reliability and based on the manufacturer's equipment.
  - 2.3.2.1. In the areas considered residential as shown on the attached map, 12 dB building loss will be added to the baseline signal level required for on street portable coverage.
  - 2.3.2.2. In the areas considered medium density as shown on the attached map, 17 dB building loss will be added to the baseline signal level required.
  - 2.3.2.3. In the areas considered high density as shown on the attached map, 23 dB building loss will be added to the baseline signal level required.
- 2.3.3. Coverage for tactical non-critical communications is as provided by PRWN (with supplements and additions for those areas defined by # and ^)

### 2.4. Capacity

- 2.4.1. Geographic Descriptions used for Traffic Modeling for PRWN trunking system usage.
  - Simulcast B –generally including the area defined as south of Carefree Highway and north of South Mountain, on the east by Scottsdale Road and on the west at approximately 75<sup>th</sup> Ave. (Phoenix Corporate areas).
  - Simulcast C – generally defined as the city of Phoenix areas south of South Mountain, plus the cities of Tempe, Chandler and Sun Lakes.
  - Simulcast E – generally including the area defined as south of Carefree Highway and north of the Sierra Estrella Mountains, west of the Simulcast B area, and east of the White Tanks Mountains.
  - Daisy Mtn – generally including the area defined as north of Carefree Highway and up to and including the Daisy Mountain Fire District.
  - Waddell Dam –generally including the area defined as around and including Lake Pleasant.
  - Goodyear – generally including the area defined as around and including Estrella Mountain Ranch.

### 2.4.2. Traffic Load Profile

The following chart shows the radio resources required to handle the traffic load represented by each incident type.

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Incident Type	Monitored Simplex Channels Required	Non-Monitored Simplex Channels Required	Talkgroups Required	Talkgroup Load Profile
E M S			1	2
3-1 Structure Fire	1			
First Alarm and Greater Structure Fire	1	1	2	2
High Rise Structure	1	1	2	2
Hazardous Materials	1	2	3	2
Special Operations	1			

All traffic loading calculations must assume the presence of “normal” PRWN trunking system traffic in addition to the incidents detailed above.

Normal traffic is defined as:

Incident Type	Talkgroups Required	Talkgroup Load Profile
Dispatch Traffic	1	Dispatch
Training and Incidental	1	1
Normal Incident Response Traffic	1	2

The load profiles referenced above are defined as:

Load Profile	Channel Seconds / Hour	Average PTT Duration	PTT / Hour	Source
0	100	5 Sec	20	Derived from Channel 8
1	400	5 Sec	80	Derived from Channel 8
2	1000	5 Sec	200	Channel 8 No Major Incident
3	2500	5 Sec	500	Channel 8 2A Haz Mat
Dispatch	1500	10 Sec	150	Channel 1

PRWN is divided into a series of infrastructure subsystems. For Fire Department traffic loading simulation purposes, each subsystem has been assigned a specific incident combination in order to project the number of simplex and trunked radio traffic required on each subsystem.

Subsystem	Simultaneous Incidents	Monitored Simplex Channel Requirements	Non-Monitored Simplex Channel Requirements
Simulcast B	One (1) Haz Mat	1	2
	One (1) High Rise	1	1
	Two (2) First Alarm or Greater Normal Traffic	2	2
Simulcast C	One (1) Haz Mat	1	2

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	Two (2) First Alarm or Greater Normal Traffic	2	2
Simulcast E	One (1) Haz Mat	1	2
	Two (2) First Alarm or Greater Normal Traffic	2	2
Outlet Mall IR	One (1) Haz Mat Normal Traffic	1	2
Waddell Dam IR	One (1) Haz Mat Normal Traffic	1	2
Goodyear IR	One (1) Haz Mat Normal Traffic	1	2

### Composite Simplex Channel Requirements (Monitored):

- For each coverage region (roughly equivalent to Simulcast B, C, & E boundaries) two (2) simplex channels with associated infrastructure are required.
- For the entire coverage area, three (3) wide area simplex channels with associated infrastructure are required.
- This provides five (5) simplex channels available for use with associated infrastructure in any given area, with a minimum of two (2) simplex channels dedicated to each area.
- If necessary for technical reasons, the requirements for three (3) wide area channels that cover the entire service area can be satisfied by splitting the area into two zones, with two (2) channels for each zone area (e.g. – north and south zones that overlay the coverage regions)
- The system shall be designed to accommodate expansion in both the area-specific channels and the wide-area channels as capacity requirements increase.

### 3.0 Interoperability

Defined as a communication link (connectivity) and the appropriate operating practices between the fire services departments that operate using the PRWN (as determined by automatic aid agreements with the City of Phoenix Fire Department) and Phoenix valley area law enforcement entities which allows radio users the ability to communicate with each other, on demand and in real time. ^

- 3.1. Connectivity between the PRWN fire services agencies, including Phoenix, Mesa, Tempe, Chandler, Glendale, Peoria, Scottsdale, Avondale, Chandler, Goodyear,

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Guadalupe, Tolleson, Sun City, Sun City West, Sun Lakes, Surprise, El Mirage, and Daisy Mountain, and these agency's corresponding law enforcement entities.

- 3.2. Connectivity between the PRWN fire services agencies and other valley area law enforcement entities including the Maricopa County Sheriff, Arizona Department of Public Safety, and Federal Bureau of Investigations.
- 3.3. Development of operating practices and training for dispatchers and radio operators.

### 4.0 Network Transport Requirements

#### 4.1. Microwave System

- 4.1.1. Capacity – The City's network transport facilities will be expanded to support the critical response and reliability requirements consistent with public safety type services.
- 4.1.2. Reliability – Any PRWN system transport services are required to use City owned and maintained facilities to support critical reliability and maintenance criteria.

### 5.0 Site and Facility Requirements

- 5.1. All towers, shelters and other remote communications infrastructure will be equipped with the appropriate electrical and mechanical facilities to support the critical response and reliability requirements consistent with public safety type services.

#### **Symbol Key:**

\* - A \* symbol after a specific numbered requirement is considered a overlay to the existing PRWN system service area to support improved and necessary operational safety for the Phoenix Fire Department and their automatic aid partners.

# - A # symbol after a specific numbered requirement is considered a supplement or modification to the existing PRWN system service area to provide necessary services to support non-covered areas for existing PRWN (automatic aid partners) members (i.e. – Goodyear, Peoria, Surprise and Scottsdale).

^ - A ^ symbol after a specific numbered requirement is considered a PRWN system enhancement or expansion due to an increase or area expansion in Fire Department services (i.e. – Buckeye).

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### Standards related to Incident Operations

- National Fire Protection Code Reference 1221 – Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems - 2002 Edition.
  - Section 4.1.2(2) – In the event of the loss of function of communications equipment, an alternative means of communications shall be readily available.
  - Section 4.1.7 – Equipment ... capacities shall be designed to handle peak loads rather than average loads.
  - Section 6.6.1 - Communications centers shall have a logging voice recorder, with one channel for each of the following: (1) Each transmitted or received radio channel or talk group
  - Section 8.1.2.6 – The radio communications system shall be monitored as follows: (1) It shall indicate faults and failures, (2) Audible and visual indications of faults or failures shall be provided to the telecommunicator and radio system manager, (3) Monitoring for integrity of portable radios and radio equipment installed in an ERF and in emergency response vehicles shall not be required.
  - Section 8.3.1.3 – A separate simplex radio channel shall be provided for on-scene tactical communications.
  - Section 8.3.4.1.26 – Tactical Communications. Trunked system talkgroups shall not be used to fulfill the requirements for the provision of a simplex radio channel for on-scene tactical communications.
  - Section A.8.3.1.3 – The telecommunicator should have the ability to monitor all tactical radio communications.
- National Fire Protection Code Reference 1561 – Standard for Emergency Services Incident Management Systems – 2002 Edition.
  - Section 3.3.23 – Radio Communications. Definitions of Command Channel, Dispatch Channel and Tactical Channel.
  - Section 4.3 – Communications. Section on communications procedures to support incident management system and operating procedures.
- OSHA (Act of 1970) – Section 5(a). Duties
  - (a)(1) Each employer shall furnish to each of his employees employment and place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees
  - (b) Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.
- OSHA Reference – 29 CFR 1926.65 Hazardous Waste Operations and Emergency Response
  - (d)(3) “Elements of the site control program.” The site control program shall, at a minimum, include: ..., site communications including alerting means for emergencies, ...

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### - Historical Background Information

- Areas as defined by the PFD Existing VHF System. These are not operation boundaries.
  - North – Covering the area north of approximately Happy Valley Road and up to and including the Daisy Mountain Fire District.
  - Phoenix North – Including that area south of Happy Valley Road and north of Northern Ave, on the east by the Phoenix corporate boundary and on the west at approximately 59<sup>th</sup> Ave.
  - Phoenix South – Including the area south of Northern Ave and north of South Mountain, on the east by the Phoenix city corporate boundary and on the west by approximately 75<sup>th</sup> Ave.
  - Southeast – Covering the city of Phoenix areas south of South Mountain, plus the cities of Tempe, Chandler and Sun Lakes.
  - Southwest – Includes the area east of Buckeye city limits but including Goodyear and to the boundary with the Phoenix South area. The northern border is approximately Northern Ave.
  - Northwest – Covers the area to the west of the Phoenix North operational area and north to approximately Carefree Highway.

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### Technical Solutions

#### Requirements for RSSP Design:

- All on-scene incident operations will use analog, simplex communications between units, and between any unit and the incident commander.
- The alarm room must be able to monitor and transmit using the critical simplex direct communications network.
- Unit to unit, and unit to Incident Commander on-scene communications will use 700 MHz or 800 MHz analog technology

#### Goals (From Project Management Plan):

- Transition PFD and Auto Aid Partners to PRWN (w/ Safety Enhancement) by 5/31/07
- Complete Requirements Definition Document by 6/3/05
- Complete Conceptual Design by 11/15/05
- Complete Detailed Design by 6/1/06
- Installation, Training, Deployment

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#### **Technical Solution #1 – Obtain authorization or regulatory rule waivers to support the use of analog simplex channels for use by PRWN for the RSSP design.**

Version 1A – Uses the FCC assigned 700 MHz direct simplex analog channels as allocated in 90.531(b)(3) and 90.531(b)(4).

Version 1B – Use 800 MHz frequencies currently used in the PRWN system design, either from simulcast subsystems or IR sites.

Version 1C – Use 800 MHz frequencies currently in use the PPD mobile data system, or other currently licensed and operating system.

Version 1D – Obtain an allocation from the 700 MHz general allocation pool.

Description: The defined requirements involve the use of analog simplex channels for hot zone and on-scene incident communications. Further regulatory complications involve the use of the channels for wide area operations to support connectivity to the PFD Alarm Room. These channels are not currently licensed by the City of Phoenix for this type of operation. Acquisition and authorization of the frequencies will be required to meet the functional and capacity requirements as defined. Reductions in capacity projections will be affected by the use of the PFD portions of the network by other users, especially in the outlying areas of the network.

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Technical Implications: Use of analog simplex channel for fire ground operations will reduce the load currently projected for the PRWN trunked network.

Version 1A – Channels are currently allocated in 6.25 kHz blocks, requiring aggregation for sufficient bandwidth. Possible capacity issues (limited channels available) and interference from electronic equipment and TV stations operating in the 700 MHz band.

Version 1B – Reduces capacity in PRWN system for other departments, especially in outlying areas. Possible to use 700 MHz channels to restore capacity to PRWN system.

Version 1C – Would require replacement of PPD data system, possibly with 700 MHz mobile data system using wide band channels for improved performance and capacity.

Version 1D – Minimal impact to existing PRWN operations and other systems.

Regulatory Considerations: Any currently conceived technical solution to meet the RSSP requirements will involve some type of regulatory clarification or rule waiver for the use of 700/800 MHz analog simplex channel for the defined method of operation.

Version 1A – The presently allocated channels for direct simplex operation are assigned with 6.25 kHz bandwidth. Current technology will require an aggregate 12.5 kHz channel. Also, the channels are subject to potential interference with TV broadcast stations.

Version 1B – Channels currently not authorized by FCC for use in this type configuration. Would require FCC rule waiver to authorize simplex, non-trunked use.

Version 1C – Licensing existing channels for use in RSSP would require FCC rule waiver to authorize simplex, non-trunked use.

Version 1D – Would require the City to petition the Arizona Regional Committee for a modification to the regional plan for use of the 700 MHz channel in this manner. Bordering regions would have to approve as well. A FCC waiver would be required.

Schedule Impact: The application process for FCC rule waivers and the subsequent consideration by the FCC can be time consuming. Experience suggests the time required will range from 6 months to possibly a year or more. Some of the time constraints are required by law for the posting of public notices to solicit comments on the request. Other time considerations deal with the Commission’s analysis of potential precedence associated with the waiver and its impact to other regional planning efforts.

Staffing and Personnel Considerations: As any acquisition strategy will require a significant work effort to produce the required documentation for the Arizona Regional Committee and the Federal Communications Commission. Typically, a licensee will retain legal counsel to prepare

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<p>the necessary filings and for representation before the Commission. The City’s technical staff provides support during the filing process with the necessary technical information and to answer technical questions in response to FCC inquiries.</p>
<p>High Level Cost Estimates – Cost estimates to retain legal and technical support staff for this effort range from approximately \$250,000 (Version 1A) to over \$1 million (Version 1D). These estimates to obtain FCC rule waivers are based on past history with similar efforts and have a high degree of volatility due to the changing regulatory environment associated with public safety and homeland security.</p>
<p>Overall Risk Assessment – The acquisition and licensing of 700 MHz frequencies (Version 1A and 1D) carry the greatest regulatory risk and associated time, but have the least impact to other systems and the cost associated with changes to those systems.</p> <p>Version 1A has the advantage of the Commission’s previous acknowledgement of the need for analog simplex operation for incident situations, but also potentially requires the most time to clear the upper portion of the band of all potential interference from TV stations in Arizona.</p> <p>Version 1B and 1C will require waivers associated with the use of frequencies in the non-trunked mode of operation. While a viable regulatory option, the cost associated with the technical conversion or replacement of the equipment to maintain the level of service is the most expensive.</p> <p>Version 1D is a viable option with significant regulatory challenges thus requiring the development of considerable documentation, both legal and technical, to support the regulatory petition and rule waiver process.</p>
<p>Additional Comments from Technical Team Members - The technical team recommends that the frequency acquisition and regulatory approval process proceed in parallel with the conceptual design.</p>
<p>Traceability to Requirements – Section 1.2, 1.3, 1.4, 1.5, 2.1, 2.3, 2.4.2.</p>
<p>Overall Assessment from Technical Team – Regulatory challenges will be difficult and should be supported by fire services trade groups and public safety user community, both locally and at the national level.</p>

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**Technical Solution #2 – A transmitter/receiver network would be designed and installed to route all critical on-scene incident communications to and from the Phoenix Fire Department Alarm Room.**

Version 2A - Network of transmitters and receivers/voters to relay all on-scene incident (critical) communications between the PFD Alarm Room and those units/incident commanders operating at the incident location using simplex communications.

Version 2B – Vehicular repeaters would be installed in fire vehicles that would use the PRWN system to route audio to and from the alarm room location. Due to the projected capacity of the simplex network, and the complexity of this technical option operating in an incident scenario, this is not practical a solution for the Phoenix Fire Department. All further descriptions in this section are referenced to Solution 2A.

Description: The overall design concept is similar to the existing PFD radio system. All on-scene incident communications unit transmissions are routed as appropriate between the field units and the PFD Alarm Room. Each channel involved in the critical tactical simplex direct solution would need the appropriate equipment configuration. The extensive nature of the network(s) is predicated on final capacity requirements and projected geographic area definitions and boundaries.

Technical Implications: Build-out of simplex system with communications to and from the PFD Alarm Room over a wide area will require a significant number of transmitter and/or receiver sites (estimated at 60+). Number of sites depends significantly on location of sites related to neighboring interfering sites with possible increase in receive only sites due to interference issues. Also, any expansion areas will need additional sites for coverage. The current PFD conventional VHF system uses approximately 35 sites to provide the necessary coverage and connectivity.

Additional sites and capacity will impact the microwave network capacity and routing, requiring expansion and potential routing changes.

Use of analog simplex channel for fire ground operations will reduce the load currently projected for the PRWN trunked network.

Schedule Impact: Conceptual and detailed design estimated at 6-12 months. Site selection and zoning restrictions are greatest challenges to schedule. Portions of the network implementation could proceed until all sites are obtained and constructed. A reasonable estimate at network completion is 2-3 years. Expanded service areas could require additional time.

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Staffing and Personnel Considerations: Additional staff would be required to support the conceptual and detailed design process, and well as the implementation oversight and testing. The appropriate project management staff should also be provided.

Additional operations and maintenance staff would also be required to operate and maintain the simplex network electronic equipment and additional sites after implementation is complete.

High Level Cost Estimates - Conceptual design needs to be completed to accurately estimate project costs. Final costs are greatly dependant on the sites selected and the associated construction requirements, interconnect network equipment, and radio equipment. Current projections are approximately \$24-26 million for the infrastructure to support PFD Alarm Room connectivity. An additional \$5 million is estimated if 700 MHz equipment is needed for the PRWN system to maintain existing capacity.

Overall Risk Assessment – Greatest technical challenges are related to the site selection process and the resulting interference associated with the site selection. To reduce the possibility of interference, receiver sites must be physically separated from high power transmitters. Further, the prospect of a receiver site becoming ineffective after implementation always exists due to the placement of future high power sites.

Additional Comments from Technical Team Members – Overall cost estimates are only within rough order of magnitude. Costs for site acquisition, civil construction, connectivity, legal costs and staffing considerations are all variables with the potential for significant fluctuation.

Traceability to Requirements – 1.1.1, 1.4, 1.5.1, 2.3.2, 2.4.2.

**Technical Solution #3 – Solutions for Interoperability Definition**

Version 3A – Expand solution currently being implemented as part of the Department of Justice Interoperability Program by installing additional control stations or console equipment at those locations not equipped to support interoperability with Fire Services.

Version 3B – Equip those entities with defined interoperability capabilities with PRNW radios or convert those users to PRWN members for full time use of the PRWN system.

Description: Connectivity to support interoperability can be provided with equipment operating directly on the PRWN system, or by using equipment patching capability. Interoperability

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requires actual procedures and practices to support field operations.
Technical Implications: Patching equipment for Version 3A can be supported with negligible impact to PRWN, if limited talkgroup are provided. For Version 3B, the technical impact will be based on the number of users, service area and other operational requirements (i.e. – talkgroup plan, roaming, etc).
Regulatory Considerations: The addition of radios (control stations or mobiles/portables) on the PRWN has no immediate regulatory constraints. However, the addition of a significant quantity of new radio users will require added capacity to the infrastructure requiring the acquisition of additional spectrum.
Schedule Impact: Control stations and patching equipment can be installed within months, based on equipment delivery cycles. The addition of new users could require significant time based on the degree of infrastructure additions or modifications.
High Level Cost Estimates – The cost of the equipment and installation is estimated at approximately \$25000 per site for Version 3A. The costs for the addition of new users will be based on technical and operation considerations, such as number of users and area of operations.
Overall Risk Assessment – New users have an impact to system performance. System engineering, operations and maintenance are all impacted depending on the size of the user community.
Traceability to Requirements – Section 3.

<p><b>Technical Solution #4 – PFD Alarm Room Indicators</b></p> <p>Version A – 7x24x365 technical support staff for PFD to provide alerting and analysis capabilities in real time.</p> <p>Version B – PRWN alarm and status information is transmitted to external alarm and reporting mechanism designed and built for PFD.</p>
<p>Description: As the operation of PRWN has a direct impact to the emergency services provided by the Phoenix Fire Department and their automatic aid partners, dispatchers need information related to the status (i.e. – health) and capacity (i.e. - % busy) of PRWN.</p>

Phoenix Fire Department Radio System Safety Project  
**Requirements Definition**  
**Technical Solutions**

<p>Technical Implications: The PRWN alarm and control equipment provides data related to status and capacity, but the data is not displayed in a “user friend” format. Significant technical knowledge of the system design is required to translate the data into meaningful information that would be useful to PFD dispatch operations.</p>
<p>Schedule Impact: A design and development effort to support an automated alarm and display functionality is estimated at about 6-9 months for a fully functional system, including the requirements definition, prototype testing and debugging phases.</p>
<p>Staffing and Personnel Considerations: 24x7 operations center requires significant staffing additions for ITD. A custom developed automated system does not require ongoing operational staff.</p>
<p>High Level Cost Estimates – Cost for 24x7 staffing is based on salaries and benefits. Development estimates for automated system estimated at \$300,000.</p>
<p>Overall Risk Assessment – Custom developed systems typically carry risks for performance and long term support.</p>
<p>Traceability to Requirements – 1.4.9, 1.4.10.</p>