FCI Technology Investigations
P34: An overview

AGCFG/4

13-14 September 2007, Brussels

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Agenda

- Overview of Public Safety Radio Systems
- P34 – key features

For reference

- P34 – slides with additional information

Public Safety Radio Systems: Open Standards

EUROPE

- TETRAPOL http://www.tetrapol.com/
- ETSI: TETRA (Terrestrial TRunked RAdio) http://www.tetramou.com/

Japan

- ARIB (Association of Radio Industries and Businesses) http://www.arib.or.jp/english/index.html

US

- IDRA (International Disaster Recovery Association)
- APCO (Association of Public-Safety Communications Officials) http://www.apcointl.org/

International

- MESA http://www.projectmesa.org/

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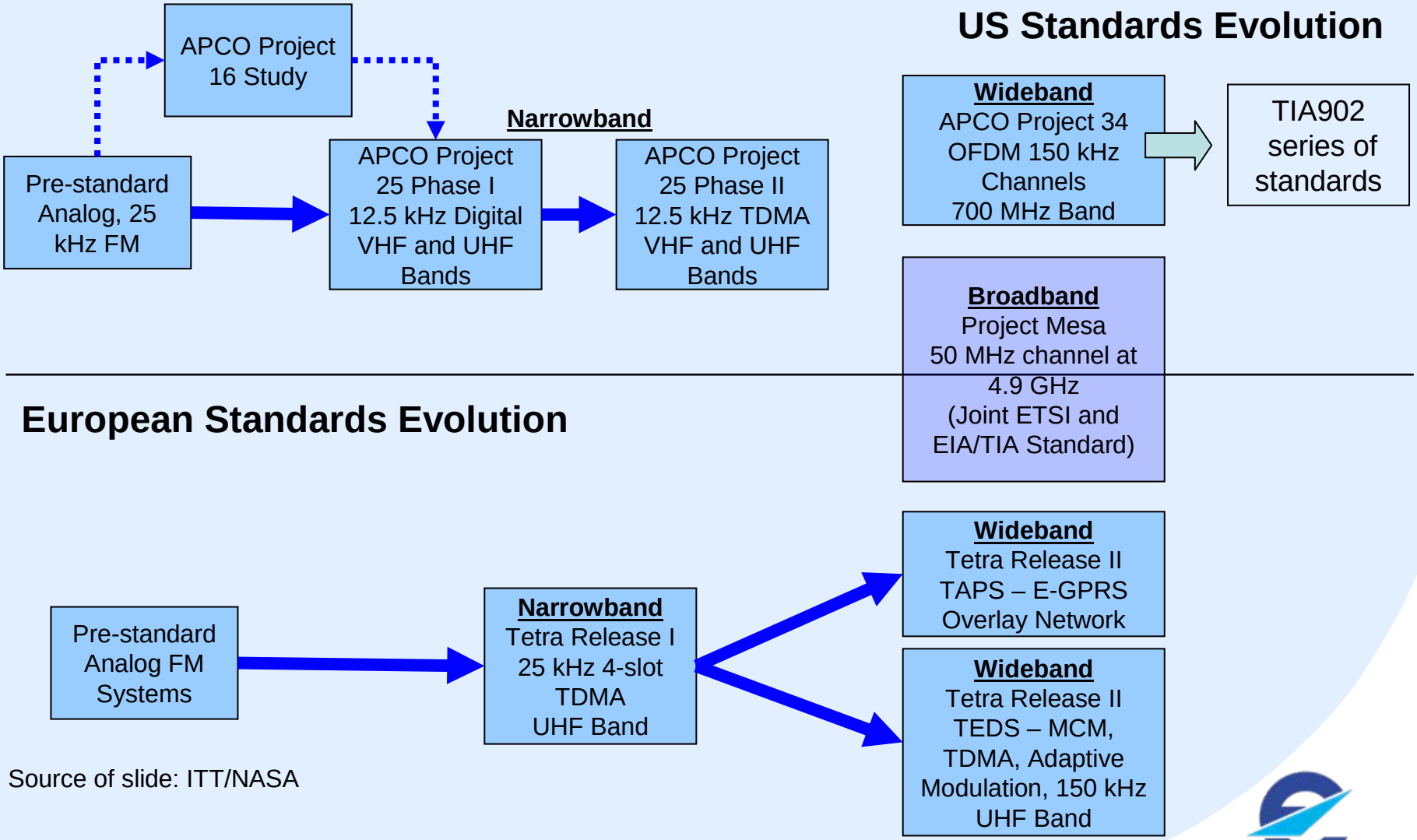
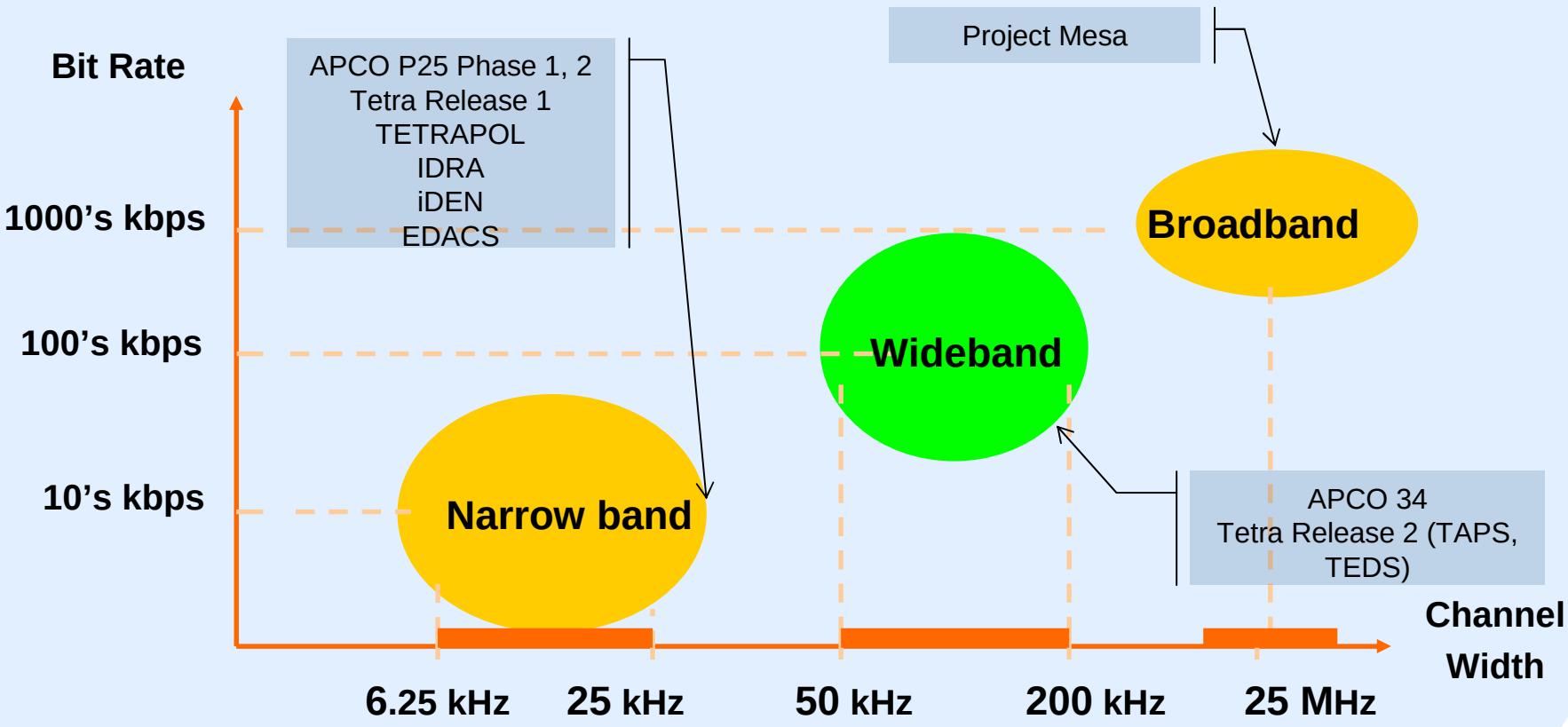
Evolution of Public Safety Radio Standards



Source of slide: ITT/NASA

PSR Systems: Throughput and Bandwidth



Source of slide: ITT/NASA/EADS

TIA902 (P34) Key Features (1/2)

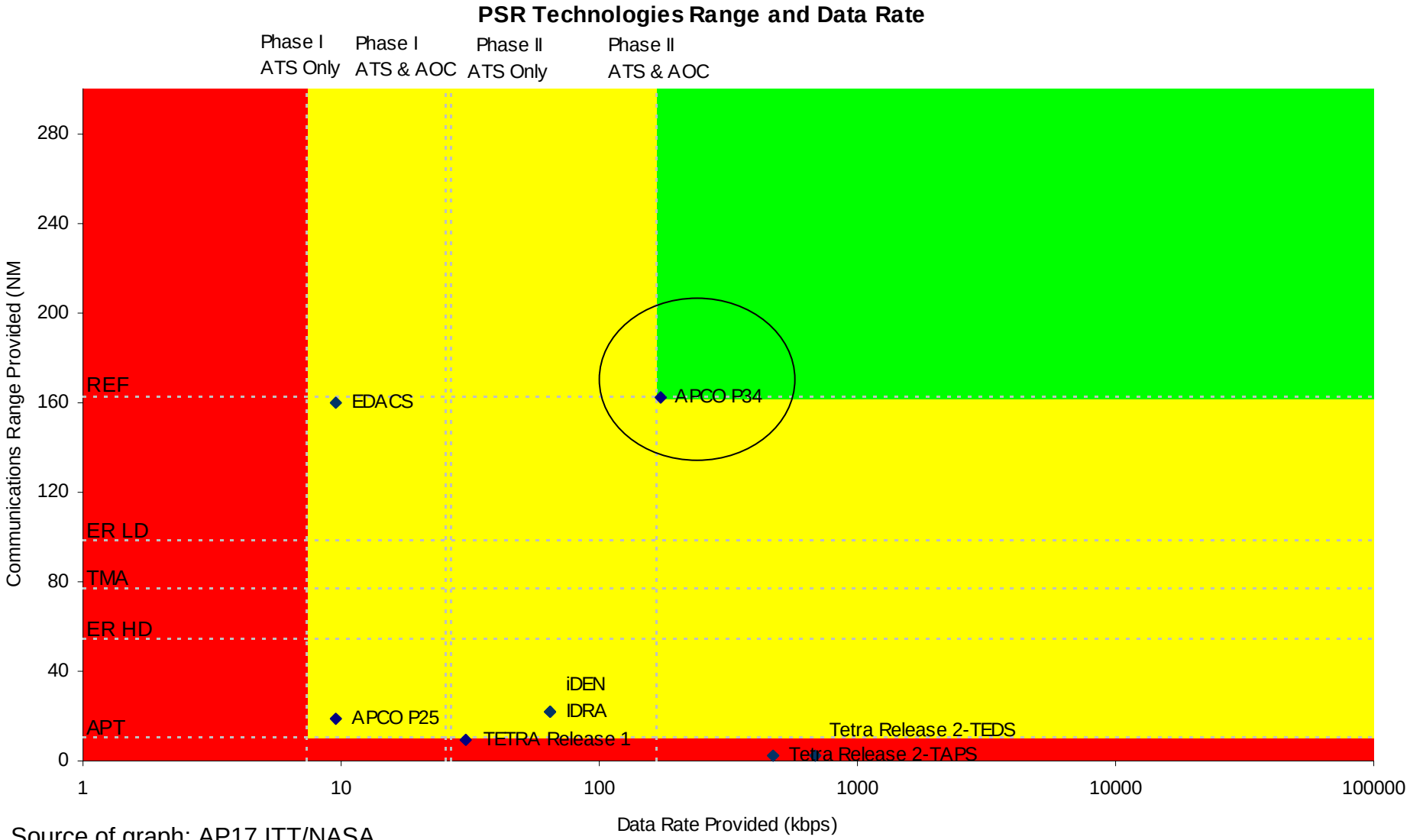
- (US) government – commercial initiative [joint activity of APCO (Association of Public Safety Communications Officials) and the NTIA (National Telecommunications Industry Association)
- Aim to “address issues that restrict the use of commercial services for mission critical public safety wireless applications”
- Support packet data services within a highly scalable and a controlled IP network
- Supports mobile to mobile and mobile to fixed infrastructure communications
- US frequency allocations
  - Forward (up-) link 767-773 MHz
  - Reverse (down-) link 797-803 MHz

TIA902 (P34) Key Features (2/2)

- Technical Characteristics
  - Frequency Division Duplexing (FDD) system using multi carrier modulation (Orthogonal Frequency Division Multiplexing, OFDM)
  - Variable Channelisation (50 KHz, 100 KHz and 150 KHz
  - Variable Throughput:
    - 76,8 Kbps (50 KHz, QPSK) to 691,2 Kbps (200 KHz, 64QAM)

- Issues for considerations
  - IPR status
  - Need for modifications
    - Operating band
    - Increase range (slot guard time)
    - …

Evaluation of Public Safety Radio Systems



Source of graph: AP17 ITT/NASA

P34 Additional information

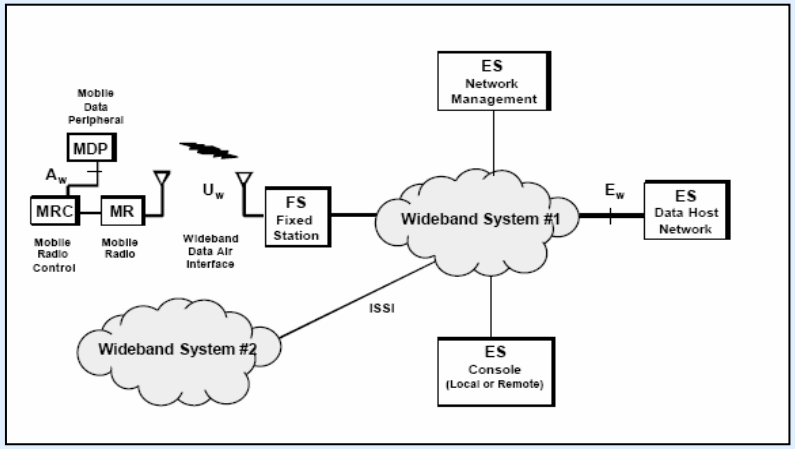
Material presented to ACP/WGC/11 meeting by:

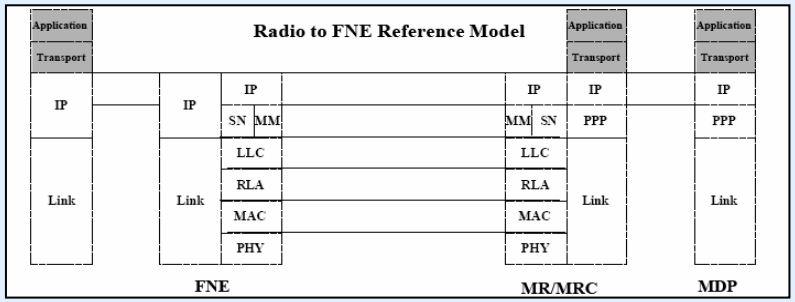
ITT/Glen Dyer
NASA/James Budinger

P34 Overview

- APCO Project 34 is a EIA/TIA standardized system for provision of packet data services in an interoperable dispatch oriented topology for public safety service providers
  - Standards available here: http://global.ihs.com
  - Example standard description
    - TIA-902.BAAB - Complete Document Revision: A Chg: Date: 09/23/03 WIDEBAND AIR INTERFACE SCALABLE ADAPTIVE MODULATION (SAM) PHYSICALLAYER SPECIFICATION - PUBLIC SAFETY WIDEBAND DATA STANDARDS PROJECT - DIGITAL RADIO TECHNICAL STANDARDS
- Project 34 concept is a government/commercial partnership
  - Provides universal access to all subscribers
  - Carefully controlled and managed network
- Was developed to address “issues that restrict the use of commercial services for mission critical public safety wireless applications”
  - Priority access and system restoration
  - Reliability
  - Ubiquitous coverage
  - Security

P34 Overview (2)





- A P34 network (called a “Wideband System”) can interoperate with other P34 networks (the ISSI standardized interface) with end-systems (Ew interface) and with mobile users over the air interface (Uw)
- The air interface has defined modes between mobiles (MR to MR); between mobiles and fixed infrastructure (MR to FNE) and repeated modes for extending range to distant stations
  - Mobile Radios can serve as repeaters to extend range from FNE to distant Mobile Radios
- The protocol stack is layered, and assumes a point of attachment to an IP network

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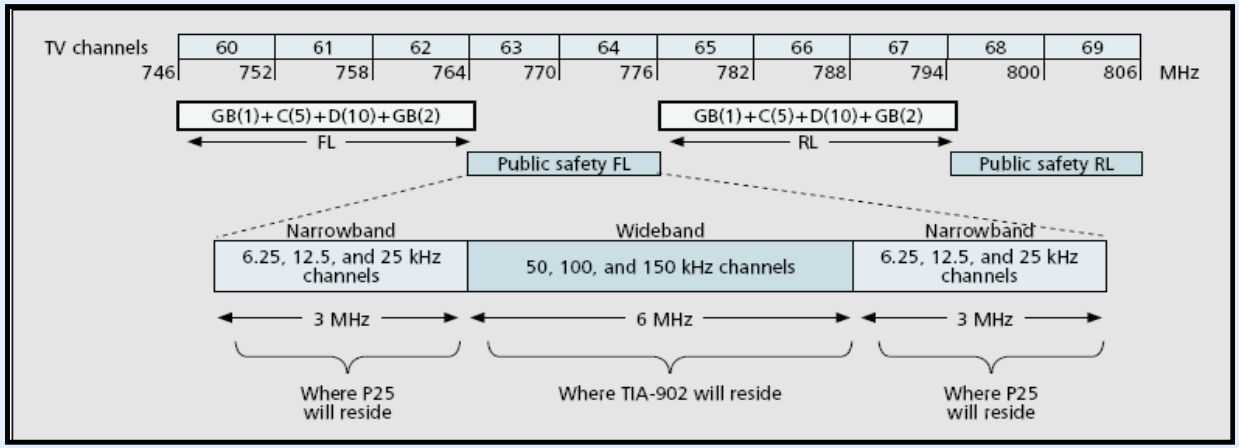
P34 Overview (3)



Source: "Spectrum Considerations for Public Safety in the United States", Tewfik L. Doumi, IEEE Communications Magazine, January 2006

- P34 systems (shown as TIA-902 in the figure) are slated to be deployed using Frequency Division Duplexing with
  - Forward Link (Fixed Network Equipment, FNE, to Mobile Radios, MRC) between 767 and 773 MHz as shown in the figure
  - Reverse Link (MRC to FNE) between 797 and 803 MHz
- The band could be cleared in some areas by December 31, 2006
  - Provided at least 85% of households have digital capable TV sets
- Most likely date is (hard requirement) January 2009

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Wideband (P34) Data Standards Status

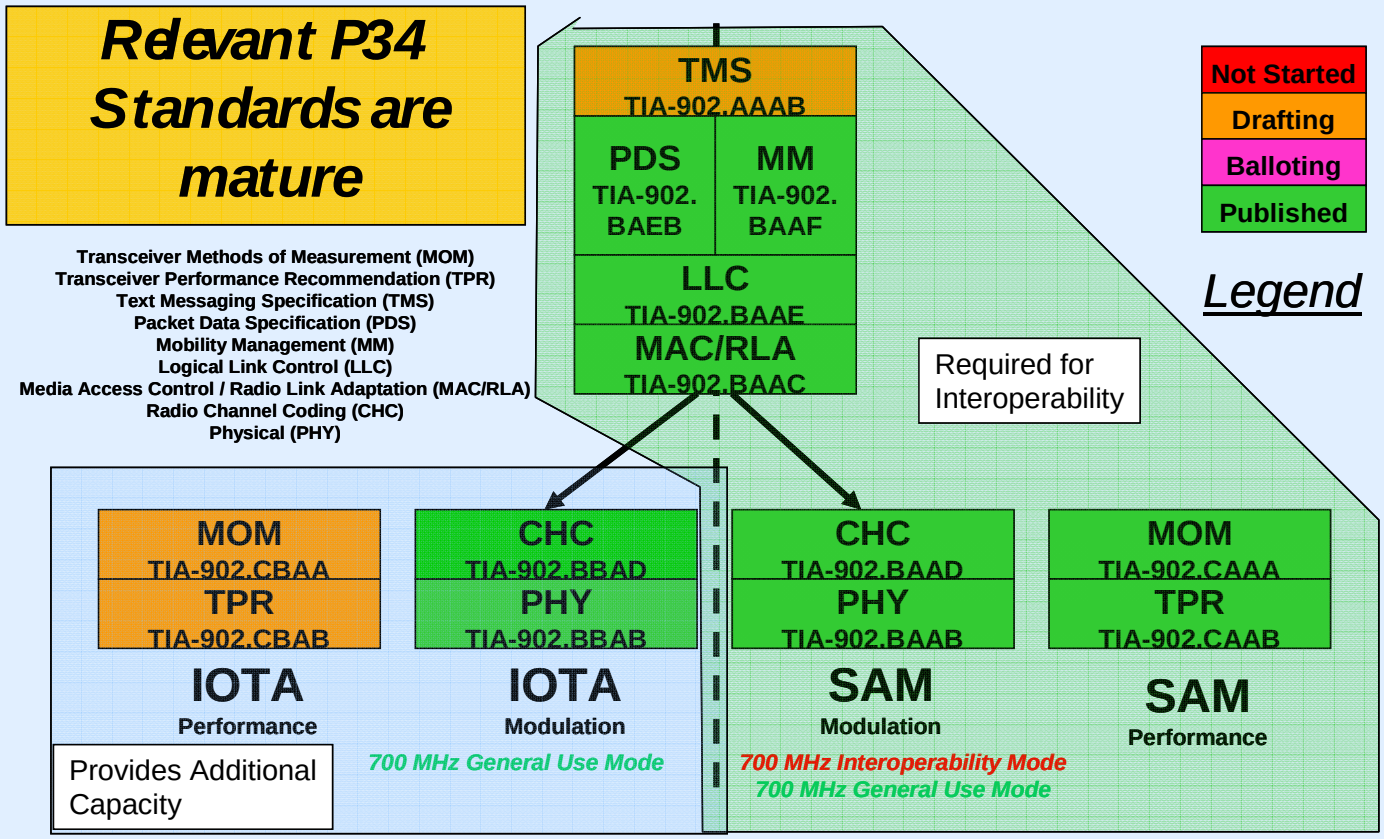

Chart courtesy of EADS Defense and Communications Systems, as provided in correspondence between ITT and EADS

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P34 Air Interface (PHY) Description

- There are two air interfaces (PHY) defined
  - SAM for interoperability
    - Has random access burst structure that incorporates 625 μs propagation guard time (187.5 km) and 208.33 μs ramp-down (not included in guard)
      - VDL 3 guard time includes the ramp-down time and is 1.14 ms (334 km)
    - Random access burst structure rules could be modified to significantly increase system range
  - IOTA to provide additional data capacity
    - Has random access burst structure that incorporates 500 μs propagation guard time (150.0 km) and 500 μs ramp-down
    - MAC uses timing advance to offset mobile propagation delays
      - From the standard: "A timing advance feature managed by the MAC layer assumes that propagation delays are not seen at the radio receiver level except for initial random access slot"
    - Random access burst structure rules could be modified to significantly increase system range

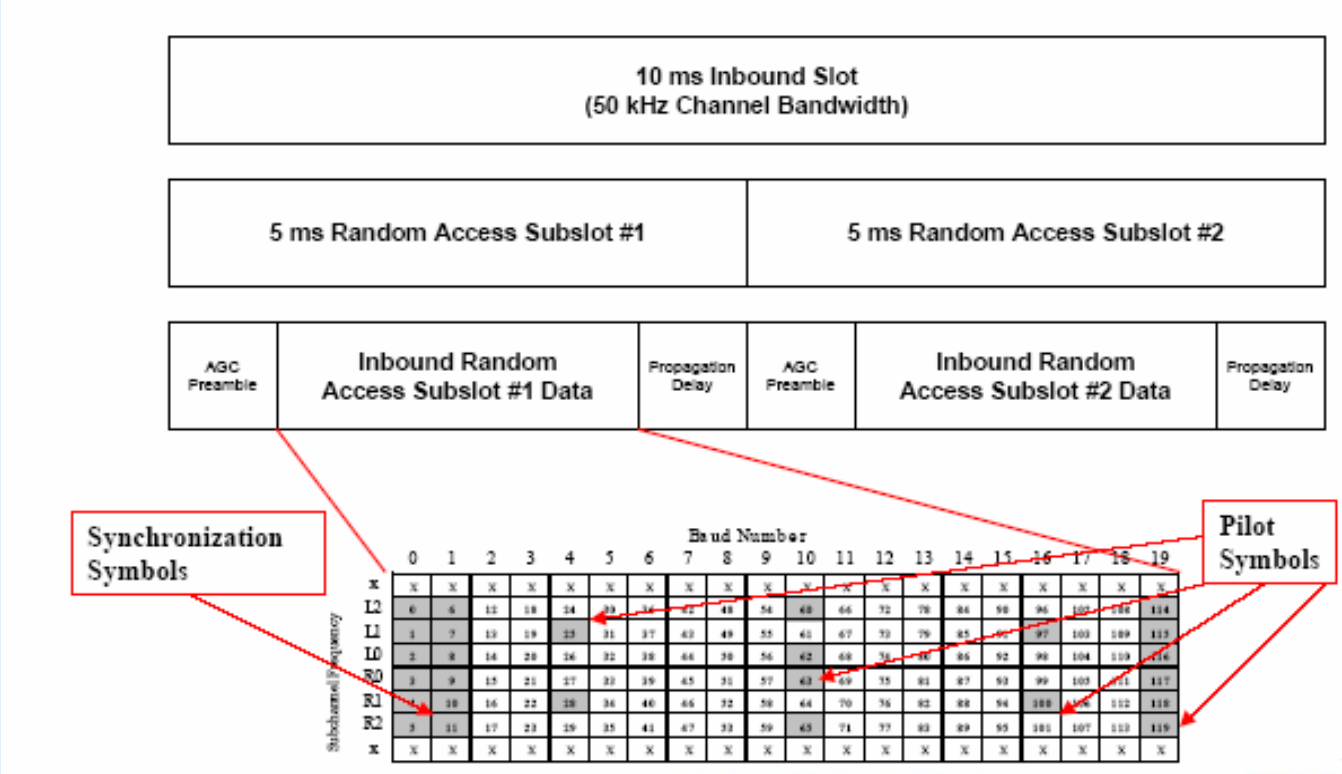
Air Interface Specifics

- Both Air Interfaces use a form of Multi-Carrier Modulation (Orthogonal Frequency Division Multiplexing, OFDM)
- Frequency Domain Extensibility
  - Base channel is 50 kHz, with extensions defined to 100 kHz and 150 kHz
  - Each 50 kHz segment is comprised of 8 subcarriers (that map to defined subchannels)
    - Concatenate subchannel sync/pilot/data structure of the 50 kHz slot two, three times
    - Simplifies receiver design
    - Completely scalable to much larger bandwidths (if needed)
  - Each 50 kHz provides 96 to 288 kbps (modulation adapts with Eb/No)

Scaleable Adaptive Modulation Parameters

Parameter	50 kHz Channel Configuration	100 kHz Channel Configuration	150 kHz Channel Configuration
RF Subchannels	8	16	24
Subchannel Spacing	5.4 kHz	5.4 kHz	5.4 kHz
Symbol Rate	4.8 k	4.8 k	4.8 k
Symbol Filter	Root Raised Cosine (α = 0.2)	Root Raised Cosine (α = 0.2)	Root Raised Cosine (α = 0.2)
Modulation Type 1	QPSK (2 bits/symbol)	QPSK (2 bits/symbol)	QPSK (2 bits/symbol)
Modulation Type 2	16QAM (4 bits/symbol)	16QAM (4 bits/symbol)	16QAM (4 bits/symbol)
Modulation Type 3	64QAM (6 bits/symbol)	64QAM (6 bits/symbol)	64QAM (6 bits/symbol)
Modulation Rate 1	76.8 kbps	153.6 kbps	230.4 kbps
Modulation Rate 2	153.6 kbps	307.2 kbps	460.8 kbps
Modulation Rate 3	230.4 kbps	460.8 kbps	691.2 kbps
Demodulation	Coherent (Pilot Symbol Assisted)	Coherent (Pilot Symbol Assisted)	Coherent (Pilot Symbol Assisted)
TDM Slot Time	10 ms	10 ms	10 ms
Slot Interleave	Variable	Variable	Variable

Inbound Random Access Frame Structure



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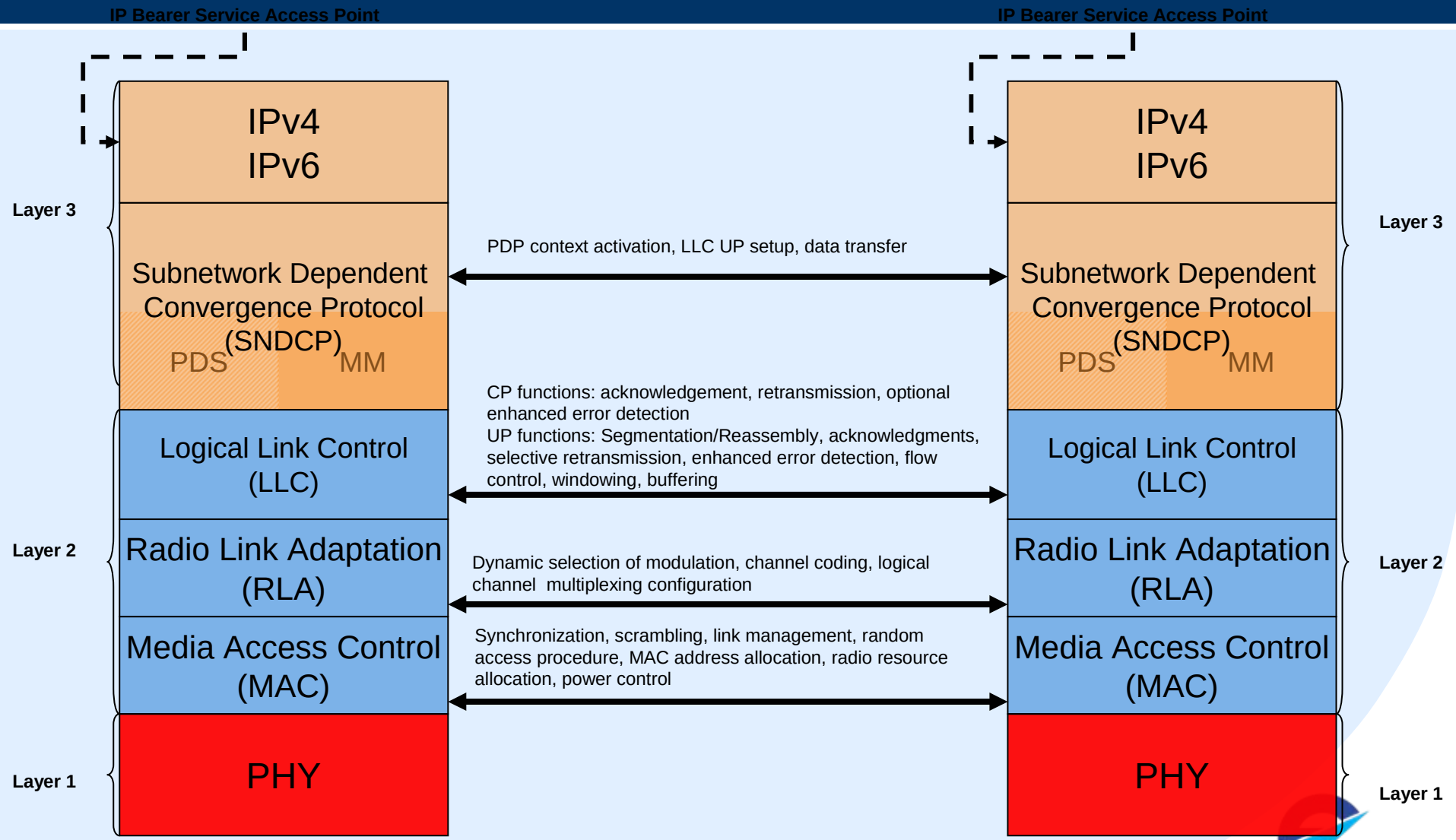
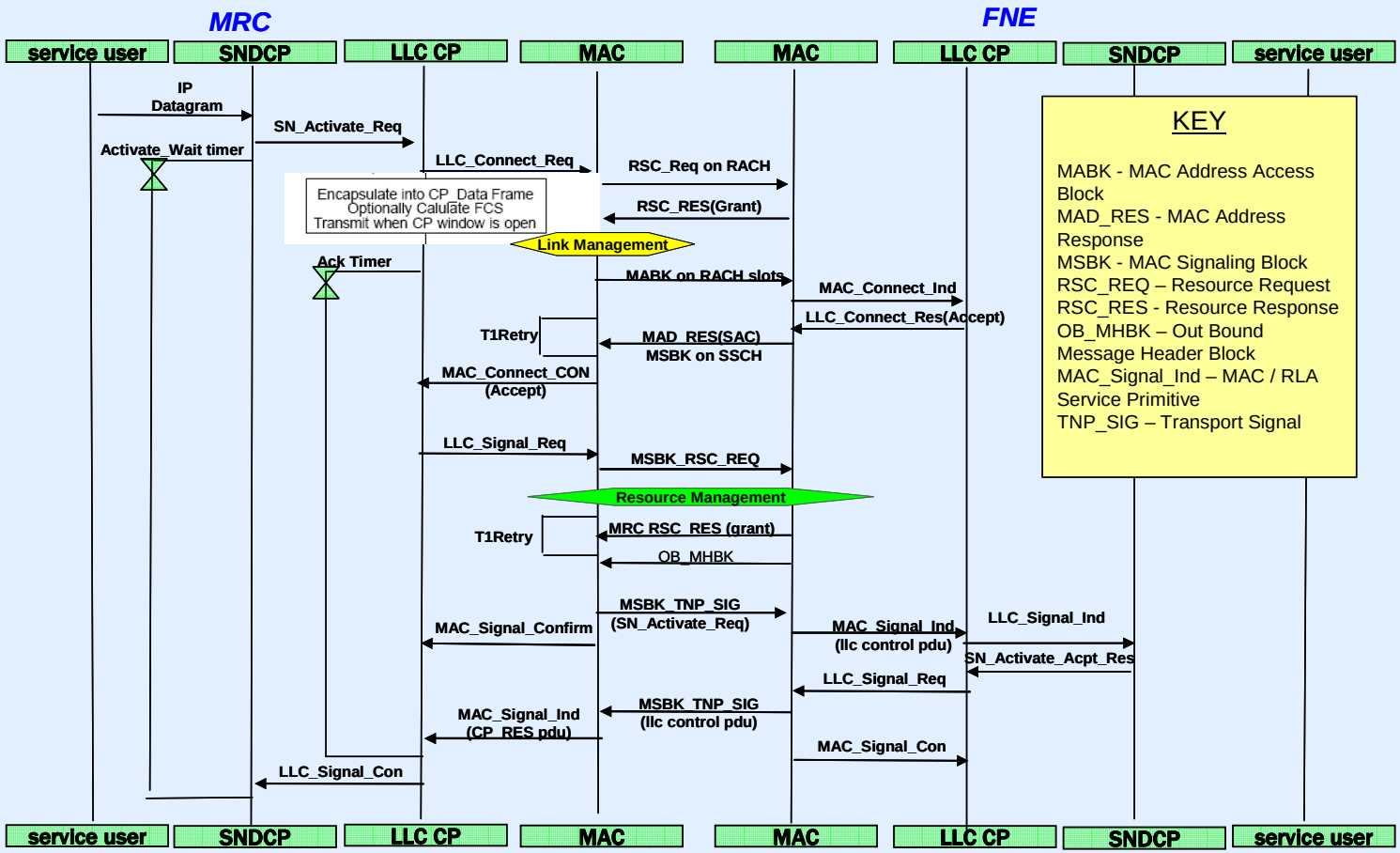
P34 Air Interface Interactions



SNDCP Context Activation Sequence Diagram



UP Acknowledged Data Transmission Sequence Diagram