Agenda

• Company introduction
• VIDA - technology presentation
  – Philosophy
  – Radio interfaces
  – Building blocks
  – Broadband data
• VIDA concept overview
• VIDA Implementations
• Lessons learned
Tyco – Leader In Each Of Our Five Businesses

- $39.7B 2005 revenues
  - $1.9B plastics (spun out).
- 247,900 employees worldwide
- 89,000 in US, 158,000 outside.

**Engineered Products & Services**
- #1 global – mechanical pipe and tube products
- #1 global – valves, US muni water M&O

**Electronics**
- #1 global - connectors
- #2 global - power supply (#1 US)

**Fire & Security Services**
- #1 global - security monitoring
- #1 global - fire contracting

**Plastics & Adhesives**
- #1 global – trash liners
- #1 global – garment hangers

**Healthcare**
- #1 global - wound care
- #1 (tied) global – laparoscopic instruments

$12.2b
$6.5b
$11.5b
$9.5b
$1.9b
$12.2b
$6.5b
$11.5b
$9.5b
$1.9b
Industry Leading Brands Enable Growth & Profitability

Healthcare & Specialty Products
- U.S. Surgical
- Mallinckrodt
- Ludlow
- Kendall

Electronics
- Elo TouchSystems
- AMP
- MACOM
- Raychem

Engineered Products & Services
- Keystone
- Grinnell

Fire & Security Services
- ADT
- SimplexGrinnell
- Wormald
- Scott

MACOM
Membe of the Tyco Family

Tyco International

• ~$40 billion manufacturing / service company

• Industry leader in each of its five business segments:
  • Healthcare Products
  • Electronics
  • Fire & Security Services
  • Engineered Products & Services
  • Plastics & Adhesives

• More than 260,000 employees

Tyco Electronics

• ~$12 billion electronics manufacturing division

• Made up of many known operating entities and brands such as AMP, Raychem, Elo Touch, M/A-COM . . .

• More than 85,000 employees

M/A-COM

• Technology leader in wireless communications

• More than 70 years of experience

• More than 3,000 employees
Integrated Products Aerospace & Defense Sector

Broadband Receivers

Components

Antennas & Cable Assemblies

Subsystems

Semiconductors
Key Markets

- Wireless Communications
  - Aerospace and Defense
  - Wireless Private Networks/Land Mobile Radio
  - Automotive Telematics
  - Wireless Data
  - Wireless Telecommunications

MACOM
Key Products/ Applications by Market

**Aerospace and Defense**
- **Major Platforms**
  - Electronic Warfare
  - Smart Weapons
  - Navigation and Communications
  - Radar Systems
  - Signal Intelligence
  - Space
  - Airborne and Ocean going platforms

- **Key Products**
  - Broadband receivers
  - Antennas and Cable assemblies
  - Multi-function assemblies
  - Semiconductors
  - Active components

- **Applications**
  - CATV
  - WLAN
  - Optoelectronics
  - Satellite Radio
  - VSAT

**Broadband & Wireless Data**
- **Key Products**
  - Amplifiers
  - Switches
  - Diodes
  - Attenuators
  - Transformers
  - Filters/Diplexers
  - Splitters/Combiners
  - Mixers

**Automotive Telematics and Sensors**
- **Key Products**
  - Adaptive Cruise Control
  - Short-range Sensors
  - Satellite Radio Antennas
  - GPS Antennas
  - Bluetooth Antennas

**Land Mobile Radio**
- **Major Markets**
  - Public Safety
  - Federal
  - Homeland Security
  - Utilities
  - Transit and Transportation

- **Key Products**
  - Amplifiers
  - Switches
  - Diodes
  - Attenuators
  - Mixers

**Wireless Telecommunications**
- **Applications**
  - CDMA
  - TDMA
  - GSM/GPRS/EDGE
  - UMTS/WCDMA

- **Key Products**
  - Amplifiers
  - Switches
  - Diodes
  - Attenuators
  - Mixers
  - Filters/Diplexers
  - Splitters/Combiners
  - Transformers
  - Converters
M/A-COM Wireless Business Systems History

The GE Era: 1928 - 1991

1920’s | 1930’s | 1940’s | 1950’s | 1960’s | 1970’s | 1980’s

- GE Mobile Radio 1934
- Microwave Associates Founded 1950
- Name Changes to M/A-COM 1978
- AMP buys M/A-COM 1995
- Tyco buys AMP / M/A-COM April 1999

The Ericsson Years: 1991 - 2001

1990’s | 2000 | 2001

- M/A-COM Merges with Com-Net Ericsson May 2001
- Tyco buys M/A-COM 2001

70 Year Legacy; > 1,000 LMR Systems Deployed
Wireless Systems

- Supplies two-way critical communications systems to the Land Mobile Radio industry
- Key locations in Lowell, MA; Lynchburg, VA; Harrisburg, PA; Burnaby, BC; and field service offices throughout the world
- Approximately 40% of M/A-COM's total business
- Major Markets served
  - Public Safety
  - Homeland Security
  - Federal
  - Utilities
  - Transportation and Transit
M/A-COM’s Global Presence

- Regional Offices (14)
  - Benshiem
  - Cambridge
  - Cork
  - Toronto
  - Madrid
  - Lowell, MA
  - Lynchburg, VA
  - Miami, FL
  - Rome
  - Sao Paulo
  - Dubai
  - Victoria

- Business Partners (>200)
  - Beijing
>500 Trunked Systems Deployed Globally

- Mexico: 4
- Argentina: 4
- USA: >300
- Canada: 45
- Europe: 40
- Russia: 7
- Korea: 7
- China: 19
- AsiaPac: 35
- Australia & NZ: 8
- Latin America: 51
- Chile: 2
- Brazil: 12
- Venezuela: 3
- KSA: 15
- UAE: 5
- Egypt: 4
- Middle East: 32
M/A-COM’s IP Based Unified Network Architecture

Voice, Interoperability & Data Access
Wireless Systems - The VI DA Network

- Network First
- OpenSky
- P25\textsuperscript{IP} Conventional Trunking
- EDACS\textsuperscript{IP}
- TETRA\textsuperscript{IP}
- Future Technologies

Internetworking

IP Application Server

IP Wide Area Network

- Transcoder Application
- Network Management
- Network Administration Switch
- Services Configuration

Voice, Interoperability, Data, Access.
What is VI DA?

- A philosophy of unifying communication resources at the network level
  - IP based utilizing COTS equipment
    - Future proof
  - Accommodates multiple air interfaces
    - P25, OpenSky, TETRA, EDACS, WiFi, WiMax
  - Interfaces legacy equipment
    - Any brand any band
  - Provides a single point of control and management
  - Is scalable and flexible
What is VIDA?

• The VIDA way

VIDA System Management

VIDA System Control

Digital NB

TETRA

EDACS

Conventional Systems

Analog Systems

IP Network

Broadband Data

VI DA System Management

VI DA System Control

3 Steps
The VIDA Model

- A Radio is a Client (Power Clients)
  - Airlink Specific Voice Format

- A Site is an Access Point (Plugs)
  - VolP Streams

- The Switch is a Server (Power Plant)
  - Analog Audio & In-Band Signaling
  - TETRA Radios
  - TETRA Site

Analog Radios
IP network

- IP bandwidth for one working channel 16 kbps
- Trunking Control LAN minimum 64kbps/site
- Distributed NSC reduces transmission needs
- Network topology can be: star, ring, grid, meshed.
IP Infrastructure benefits (1)

- Standard equipment, software, management
- Efficient IP backbone also necessary for other than PMR services
- Customers already have or built corporate IP networks
- IP compression and IP transmission of different signals continues fast developing
- IPv6 - QoS, fixed addressing, IPsec, increased mobility
- IP is basis for future mobile communications systems (UMTS)
IP Infrastructure benefits (2)

- IP wide competence support (staffing)
- Easy implementation of current IT applications
- Relative processing power/capacity of IT products grow but prices decrease
- IP networks have naturally inbuilt resilience
- In properly built IP network there is no problem of latency for voice services (dedicated routing, priorities, compression 80%)
Searching for the best solution...

... consider different requirements and limitations
Conventional Vs Trunking

• What is Trunking?
  - Automatic allocation of a pool of radio channels
  - Resource shared basis
  - Control with a dedicated control channel
  - Fewer channels required for a given number of radios
## Rural Areas

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Radio network requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large distances</td>
<td>Extensive coverage range</td>
</tr>
<tr>
<td>Low population density</td>
<td>Low/ medium capacity</td>
</tr>
<tr>
<td>Expensive/ unavailable teletransmission links</td>
<td>Minimize teletransmission needs</td>
</tr>
<tr>
<td>Low/ medium PS activity</td>
<td>Less advanced services</td>
</tr>
</tbody>
</table>
Rural area technology fitting

Radio network requirements

- Extensive coverage range
- Low/medium capacity
- Minimize teletransmission needs
- Less advanced services

Technology

- FDMA radio technology
- Conventional or Trunking
- High RF site coverage range -> low number of sites -> low teletransmission needs
- Voice + some data is enough
Urban Areas

Characteristics
• Defined area
• High population density
• Expensive teletransmission links
• Medium/ high PS activity

Radio network requirements
• High coverage requirements (in building)
• Medium/ high capacity
• Optimize teletransmission needs
• Advanced services
Urban Areas technology fitting

Radio network requirements

- High coverage requirements (in building)
- Medium/High capacity
- Optimize teletransmission needs
- Advanced services

Technology

- FDMA
- Trunking TDMA/FDMA
- FDMA - less sites
- Trunking FDMA/TDMA
## Basic Parameters Comparison

<table>
<thead>
<tr>
<th></th>
<th>Tetra</th>
<th>P25IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>TDMA</td>
<td>FDMA</td>
</tr>
<tr>
<td>Channel Spacing</td>
<td>25 kHz</td>
<td>12.5kHz</td>
</tr>
<tr>
<td>Concurrent calls per channel</td>
<td>4 (3+CC) Message Trunking</td>
<td>1 Transmission Trunking</td>
</tr>
<tr>
<td>Modulation</td>
<td>π/4 DQPSK</td>
<td>C4FM</td>
</tr>
<tr>
<td>Voice Codec/data stream</td>
<td>TETRA/7.2kbps</td>
<td>I MBE/4.4kbps</td>
</tr>
<tr>
<td>Channel throughput gross</td>
<td>36kbps</td>
<td>9.6kbps</td>
</tr>
<tr>
<td>Data Transmission</td>
<td>Real: 7.2kbps Circuit Switched 2-3kbps Packet Data</td>
<td>4.8kbps Protected Packet Data 7.2kbps Unprotected Packet Data</td>
</tr>
<tr>
<td>Channel access time</td>
<td>&lt;300-500ms</td>
<td>&lt;100-500ms</td>
</tr>
</tbody>
</table>
TETRA

• 4-slot TDMA in 25kHz channel (1CC+3WC)
• Multi-vendor, supported by ETSI
• Some features described in standard still not implemented
• Strong points:
  – Interoperability between terminals from many manufacturers
  – Very good voice quality (in stable prop. cond.)
  – Very strong marketing
• Weak points:
  – Disappointing data transmission
  – Very high cost of infrastructure (good coverage=many BS)
P25 CAI Basic Parameters

- 4.4 kb/s IMBE voice coding
- 2.8 kb/s Forward Error Correction
- 2.4 kb/s signaling, synchronization, Low Speed Data
- 9.6 kb/s Total
- DES (56 bit) or AES (256 bit) encryption
- Over-the-air Rekeying (OTAR)
- Protected Packet Data (4.8 kbps) or Unprotected (7.2 kbps)
P25 CAI - benefits

• Open standard - many suppliers
• Stable developing product
• Perfect digital voice quality
• Backward compatible with analog networks (Interworking, migration)
• Compliant with CE and EU frequency mask Narrowband Digital PMR - ECC (02)03
• Coverage similar to analog NB/ 12.5kHz
• Packet Data transmission
• Advanced Encryption algorithms
M/A-COM - P25\textsuperscript{IP}

• Project 25 to the power of IP
  - P25 CAI Common Air Interface
  - IP based backbone infrastructure
  - Conventional (P25\textsuperscript{IPC}) and trunked networks (P25\textsuperscript{IPT})

• M/A-COM implements features defined by the standard except of:
  - Triple DES, Type 1 Encryption, Circuit Data
  - Reason - low market demand
Wide Area Network - example

- ROC (Regional Operations Center)
- NOC (Network Operations Center)
- Centralized Network Administration and Management
The Interoperability Problem

- Disparate radio systems
  - Multiple technologies
    - P25, TETRA, Conventional, other proprietary protocols
  - Multiple bands
    - VHF, UHF, 800, 700

- Problem evident during recent disasters
  - Hurricane Katrina, 9/11, Florida Hurricanes in 04, Madrid Metro Bombing, London Bus Bombing, Poland Roof Collapse
  - Separate agencies simply could not talk to each other
What is NetworkFirst

- IP based Interoperability (VIDA)
  - Shares network resources
- Multi-Protocol Technology Bridge
  - Interoperates disparate radio systems
    * Any brand and band
- Scalable
  - Unlimited scalability due to IP infrastructure
Solution for Interoperability

Building Blocks

Network Administration Server
- User interface for Network Admin
- Co-located or Remote
- WEB Browser clients

IP Network

Switching Platforms
- Network Switching Center
  - Redundant Voice Switch (VNIC)
  - Network Management Server
  - High speed redundant LAN
  - High capacity redundant Routers

IP Backbone
- Private Intranet
- Built on standard Internet Protocols
- Utilizes third party equipment
- Wide variety of communication media

Interoperability Gateway
- Converts audio protocols into VoIP
- Universal audio ports
- 1 DVU card per talkpath
- Each DVU has a unique IP address

NetworkFirst

TETRA
P25
Conventional
VHF
UHF
etc

MACOM
The NetworkFirst Value Proposition

- Interoperability on demand - the ability to provide immediate communication to first responders
- Users determine who they talk to - the ability to offer trunk-like capabilities to all radio users
- A highly scalable solution - can interconnect local and state systems on a national footprint
- Builds on modern IP packet switched technologies
  - Merging of government IT & radio communication networks
- Cost effective - you don’t replace existing radio equipment
- Time effective
M/ A-COM Solution Advantages

• Licensed Band
  - Avoid interference for critical operation

• Open-standard airlink protocol [802.16]
  - Allows for future equipment interchangeability

• Air link protocol provides guaranteed QoS [802.16]
  - Support of on-demand streaming video services and VoIP services

• System provides a path to metropolitan wide-area broadband coverage
  - Scalable capacity
  - Open standard airlink with a path to true high speed mobility

• Seamless integration with the VIDA platform
The Building Blocks of VI DA

- IP Network
- Management Systems
- Switching Platforms
- (Geographically Redundant)

- IP Consoles
- IP Loggers
- Recorders
- OpenSky
- Air Interfaces, Sites
- P25
- Site 3
- 802.xx Data
- Multi-mode Software Defined Radios
- CAD Systems
- Legacy Analog Systems
- Mobile Clients
Network Switching Center

- Software Voice and Data Switch
- COTS Sun Server & Cisco Routers
- Site Routing with Optional Bulk Encryption
- Network Management Administration
- High Availability Option
VIDA Consoles

• Full Featured Dispatch Solution
  – Patch, Simulselect, Emergency
• IP Connectivity without CEC/CEB
• Encryption without DVU
• Option V\textsuperscript{IP} console
NetworkFirst Gateways

- DVU transcoders
  - Rack mount cards and cage
  - Expandable
- Connectivity to legacy systems
  - Conventional channel/ Talkgroup mapping
New York, National Capital Region Case Studies
NY Statewide Wireless Network (SWN)

Awarded Sept 05

Key Stats
- 19M people
- 141k square KM,
- 62 Counties in NY
- > 30 agencies and 65,000+ users
- 1066 sites
- 25,000 to 65,000 users

Public Safety Radio System
- Hybrid VIDA system
- Build, Deploy, Operate & Maintain Statewide Network for 20 Years
- Construction & Deployment = 58 Months
- Interoperability with Non-State agencies
NY Statewide Wireless Network (SWN)
National Capital Region (NCR)

9 Switching Centers – DC, Maryland, VA & NY

Army Installations
- FT Belvoir
- FT Myer
- FT McNair
- FT Meade
- FT Hamilton
- FT Detrick
- Raven Rock
- FT AP Hill
- Pentagon
- WRAMC

Navy Installations
- Naval Academy
- NAS Pax River
- NSWC Dahlgren
- Wash. Navy Yard
- NSF Thurmont

USMC/USAF Installations
- Bolling AFB
- Indian Head

5,000 Users Initially, Growth to 10,000
National Capital Region (NCR)

- 18 RF Sites
- 120 Mile of coverage
- Wide area communications
- Voice and data
- AES Encryption
- Over-The-Air-Rekeying
National Capital Region

Management Systems

10 Network Switching Centers

58 Civilian Radio Systems

IP Consoles

IP Network

P25 Sites in 10 Army Bases

P25 - AES Voice

P25 Radios

Civilian Radio Systems

IP Network Switching Centers

Management Systems

P25 - AES Voice

P25 Sites in 10 Army Bases

P25 Radios

Civilian Radio Systems
Interoperability Requirements

• Radio-to-radio interoperable communications with the existing P25 CAI radio systems used by the NCR and other federal LMR radio users, either with or without dispatch operator assistance.

• The system shall also facilitate interoperable communications with the following civilian public safety responders:
  - 58 Agencies
    - Twenty-two (22) 800MHz (includes Motorola Trunked)
    - Nineteen (19) VHF
    - Seven (7) UHF
    - Ten (10) Other (low band, AM, FM, 200, …)

• Note most existing equipment is Motorola
Krakow Airport upgrade
Network First Demo in Germany
Trial VI DA system in Poland

VIDA Network Switching Center

TETRA IP
Base Site

Remote
System Management

C3 Maestro
Dispatch Console

Laptop:
Proxy Server for TETRA
NF Assistant
Text Link

73 Channel
Digital Trunked Base Site
12.5 kHz / 410-430 MHz

Mobile Radios
410-430 MHz
DVU Gateway

Edge Router

Analog
Subscriber
Line

PSTN

Laptop:
VII Dispatch Console
OTAP Application

VIDA Network tests at National Institute of Telecommunications
M/A-COM Poland Sp. z o.o.
ul. Kolibrewska 57, 01-317 Warszawa Poland
Questions? And Thank You