Understanding Relevant Technologies

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Topics

• Public Safety LMR
• Satellite
• Broadband (WiMax/WiFi)
• Mobile Broadband (WCDMA/CDMA)
Wireless Access Direction

- Broadband to Edge
- RAN Agnostic
- IP Based
- Flat Architecture
- Core Based on IMS
- Harmonized ASN/CSN
- WiMax, WiFi, HDPA, EVDO
- SDR
- Interoperability via IP
LMR Radio System Types

- LMR Radio System Types
  - Conventional
  - Trunked
  - Hybrid (control station repeaters)

- All of the systems employed by public safety are for mobile communications

- Utilize a mosaic of frequencies

- All LMR Radio Systems are Narrowband

- No Interoperability Standard (P25, Opensky)
Interoperability Bridges

SR- 3001 Radio Interoperability System
Infinimux G4
INTEROP9
TRP1000 Transportable Radio Interconnect

Motobridge Soft Switched Radio Network
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NFI Gateway
Cisco IP Interoperability and Collaboration System “IPICS”
ACU1000

Rivada Networks - Proprietary
LMR Direction

- Continued Proprietary System Approach
- Voice Communications
- Limited Data
- Convergence on 700/800 MHz
- 4.9GHz
- Nationwide Build-out required
- Multiple Devices still needed for interoperability
Satellite Communication

• Broad coverage area
• Independent of Terrestrial Facilities *
• Various Satellite Architectures
  – Bent Pipe
  – Partial Processing
  – Full Processing (RSA)
• Satellite Classifications
  – Low Earth Orbit (LEO)
  – Medium Earth Orbit (MEO)
  – Geosynchronous Orbit (GEO)
• Mobile (MSS) and Fixed (FSS) platforms
Bent Pipe

- Point to Point Connection
- Simple Structure
- RF Pipe
- No Processing at Satellite
Regenerative Satellite Architecture (RSA)

- Direct ST to ST
- On Board Switching
- Multiple Gateway
- DVB-S Downlink
- DVB-RCS Uplink
- Facilitates Broadband IP Network in Sky
Satellite Direction

• Satellites will be a broadband conduit *
• IP
• Wideband payloads
• Mesh Network
• Multibeam, regenerative satellite

* Transponder limited
Connectivity Services Network (CSN)

- IP Based
- Broadband to Edge
- Core Based on IMS
- Flat Architecture
- ASN (RAN) Agnostic
IMS (IP Multimedia Subsystem)

• What is IMS?
  – IMS is the standard framework for implementing multi-media services over IP
  – Defined by 3GPP/3GPP2
  – Access Agnostic
  – SIP Based
  – Backward compatible with traditional TDM networks through a Gateway

• Therefore IMS enables the convergence of data, voice and various network topologies using a IP based infrastructure
IMS Architecture

Services

Control and Connectivity

Access

Applications and Content
Common Support Functions

HSS
CSCF
MGCF

IP Backbone

MGW

Fixed
Mobile
Wireless
Cable

MSCF – Call Session Control Function
HSS – Home Subscriber Server
MGCF – Media Gateway Control Function
MGW – Media Gateway
PSTN – Public Switched Telephone Network

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CDMA2000
GSM
UMTS
LTE
UMB

WiFi
WiMAX

ISUP

TDM

PSTN
Wireless Mesh Network

- A wireless mesh network is an array of wireless devices that can communicate to each other via multiple paths.
- Components of the wireless mesh network may or may not be the same ASN or frequency. (ie Cellular and WiFi)
- Utilizes IP (mobile/simple)
- Resiliency with added overhead
Wireless Star Network

- Traditional Configuration
- Concentration which all nodes or devices directly connected to a common element
- A link failure to a node will isolate that node from the rest of the network computer. All other nodes will continue to operate as normal.
- Failure at central, common, node will disrupt network
Flat Network

- A Flat network utilize IP to achieve connectivity
- Provisioning and Management of end devices enhanced
- Components of the flat network may or may not be the same ASN. (ie CDMA and WiMAX)
- Utilizes IP (mobile/simple)
- Large LAN
- Resiliency
ASN

- WiMAX (802.16, 802.16e)
- WiFi (802.11a,b,g,n)
- UMTS (WCDMA/HSDPA/HSUPA)
- CDMA (1xRTT/EVDO)
- UMA/FMC
- UMB
- LTE
WiMAX

- Broadband to the Edge (last mile)
- Standard 802.16e
- Utilizes licensed and unlicensed spectrum
  - MMDS in US
- Designed for a large coverage area.
- TDD Access Method
- OFDM – orthogonal frequency division multiplexing
- MIMO
- NLOS
- DL – 70Mbs, UL 70Mbs
- Mobile IP
WiMAX

• Advantages
  – Broadband to Edge (last mile)
  – Mobile
  – Standard approved and recognized
  – Complimentary to existing ASN’s

• Disadvantages
  – Needs to be built
WiFi

- WiFi is a wireless LAN based on the 802.11 standards
- Wi-Fi uses unlicensed spectrum.
  - 802.11 b/g (ISM)
  - 802.11 a (UNII)
  - 802.11 n (ISM/UNII)
- Designed for smaller coverage areas..
- WiFi is now a standard feature for laptops, computers, and PDA’s.
- The convergence of 802.11 with wireless mobility has been described as the real killer application.
WiFi

• Advantages
  – Wireless LAN
  – Established Standard
  – Universally Accepted (Laptops, PDA)

• Disadvantages
  – Limited Coverage from Access Point
  – Security
  – Unlicensed Frequency
UMTS

- UMTS - aka W-CDMA
- IMT2000
- Deployed world wide
- Utilizes GSM Core network (r99)
- Different ASN (RAN) than GSM
- Requires 10MHz (5MHz Tx/5MHz Rx)
- HSDPA (DL-14.4Mbps)
- HSUPA (UP -5.8Mbps)
- Circuit and IP Core
UMTS (HSPA)

• Advantages
  – Established Standard
  – Universally Accepted

• Disadvantages
  – Overlay Network
  – RAN upgrade for HSPA
  – Multiple Core Network upgrades
  – Not Backward Compatible to GSM
EVDO- Rev A

- Enhancement to EVDO –Rev 0
- IMT2000
- Deployed world wide
- Utilizes CDMA2000 Core network
- Different ASN (RAN) than CDMA2000 (1xRTT)
- Requires 2.5MHz (1.25MHz Tx/1.25MHz Rx)
- Rev 0 DL – 2.1Mbps/UL – 153kbps
- Rev A DL – 3.1Mbps/UL – 1.8Mbps
- Packet Based (IP)
EVDO – Rev A

• Advantages
  – Established Standard
  – Spectral Efficient
  – Backward compatible to EVDO –Rev 0 and 1xRTT

• Disadvantages
  – RAN and PDSN upgrade for Rev A
  – Overlay Network for 1xRTT
Ultra Mobile Broadband (UMB)

- OFDM /EVDO Rev C
- CDMA Technology Path
- Different RAN than EVDO Rev A
- Packet (IP)
- UMB peak data rates
  - DL - 280Mbps
  - UL to 68Mbps
- Standard Still in Development
Long Term Evolution (LTE)

- High Speed OFDM Packet Access (HSOPA)
- Super 3G and 3.99G
- GSM/UMTS Technology Path
- New air interface system and incompatible with legacy WCDMA
- 1.25MHz to 20MHz Flexible bandwidths (1.25Mhz increment)
  - 100Mbps DL - 20MHz
  - 50 Mbps UL – 20MHz
- FDD and TDD
- Packet (IP)
- Standards still in development
Wireless Mobility Paths

GSM (800/1900) → GPRS (800/1900) → WCDMA (UMTS) → WCDMA HSDPA 14Mbps DL → WCDMA HSUPA 5.8Mbps UL → LTE 100M/50M

AMPS (NAMPS) → IS-136 TDMA (800) → IS-95 CDMA (800) → IS-2000 Rev 0 → IS-2000 Rel A 384k/153k → IS-2000 Rel C 1xEV-DV 2Mbps → IS2000 Rel C 1xEV-DV 5Mbps

IS-95 (1900) → EDGE (800/1900) → TD-SCDMA

SMR → iDEN (800) → WiDEN

IS-856 Rel 0 EVDO 2.1M DL → IS-856 Rel A EVDO 3.1M/1.8M → IS-856 Rel C UMB 280M/63M

1G 2G 2.5G 3G 4G

May 11, 2007  Rivada Networks  -Proprietary
Software Definable Radio (SDR)

- SDR technologies utilize software to define ASN Modulation
- SDR’s are being commercially deployed (FCC)
- Allows one ASN platform to utilize multiple technologies
- Modulation format can be altered quickly provided it's in the waveform library
- Future proofing part of ASN
- SDR requires a PA and filters that are band specific
- Harmonization of the ASN Mosaic is possible with SDR
Fixed Mobile Convergence (FMC)

- Broadband to the Edge or anywhere
- Triple or Quad Play
  - Fixed Telephony
  - IP Telephony
  - Internet Access
  - Video
- Uses licensed and unlicensed spectrum
- Unlicensed spectrum technologies ie WiFi and Bluetooth
- Consistent user experience for their mobile voice and data services when transitioning between networks.
- Roam and handover seamlessly between private unlicensed wireless networks like GSM and LANs using a dual-mode Mobile phone.
- Enables mobile operators to deliver voice, data and IMS/SIP applications to mobile phones on any access networks.
- Femto cell
Summary

- Broadband
- RAN Agnostic
- IP Based
- Flat Architecture
- Core Based on IMS
- Harmonized ASN/CSN
- WiMAX, WiFi, EVDO, HSPA
- SDR
- Complimentary ASN’s meeting user requirements
  - Government (DoD*, Federal, State, Local)
  - Private (Business, Consumer)
- Commercial Wireless can deliver Interoperable IP Broadband Today