CDMA2000 Network Repeater Deployment Experience

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D. J. Shyy	Voice:	+1-703-983-6515
MITRE	Fax:	+1-703-983-7142
Mclean, VA 22012	E-mail:	djshyy@mitre.org
Craig Stanziano	Voice:	+1-805-499-7990
Distributed Wireless Group	Fax:	+1-949-666-9240
Newbury Park, CA 91320	E-mail:	craig.stanziano@distributed-wireless.com
Paul Lemson	Voice:	+1-425-702-0848
Juni America	Fax:	+1-425-702-0706
Redmond, WA 98052	E-mail:	paullemson@juniamerica.com

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To help shape the direction of MMR SG

CDMA2000 Network
Repeater Deployment Experience

Dr. D. J. Shyy
MITRE

Craig J. Stanziano
Distributed Wireless Group

Paul Lemson
Juni America

Outline

- Introduction
- Overview of cdma2000 networks
- Repeater deployment scenarios and experiences in cdma2000 networks
- Conclusion

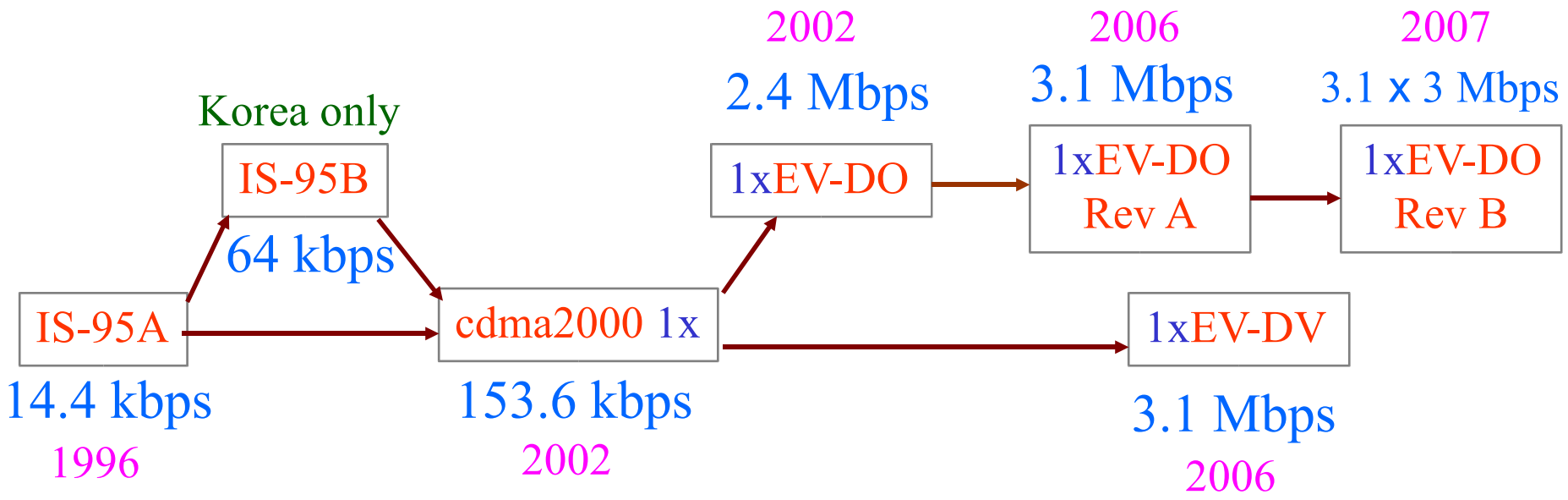
Introduction

- The 802.16 Mobile Multi-hop Relay (MMR) Study Group (SG) is in the process of soliciting contributions in the area of service scenarios and network topologies.

- This briefing presents the repeater deployment scenarios for cdma2000 networks

- The briefing also shares the experience learned from deploying these repeaters

Overview of cdma2000 Networks



- cdma2000 is one of the 3G technologies specified by the ITU
- This briefing focuses on the cdma2000 1x networks
  - It is backwards compatible with IS-95A networks
  - It provides 1.5 to 2 times increase of the voice capacity compared to IS-95A networks
  - The highest data rate per user is 153.6 kbps

cdma2000 Repeaters

- Repeaters can be considered a form of Distributed Antenna System (DAS), in which the coverage of a sector is extended to the vicinity of the repeater.

- With DAS, cell coverage (size and shape) has an ability to be adjusted dynamically.

cdma2000 Repeater Deployment Scenarios

- The following are the typical applications of repeaters (in the order of importance):
  1. In-building
     - Inclusive of underground & tunnel applications
  2. Hole filling
  3. Range extension (such as in fill for macro cell or highway cell)
  4. CDMA optimization technique
     - e.g. Creation of pilot dominance and/or improved pilot quality to a pilot degraded area

cdma2000 Repeater Deployment Experiences

- Deployment Experience
  - Success in the utilization of the repeater scenario relies heavily on its proper application (i.e. link budget discipline).
    - A good off air deployment practice is to have repeater maintain maximum gain with minimal isolation needs. The need for isolation is to prevent the unit from oscillating. Typically a 15 dB difference between Repeater gain and Port to Port (Donor/Server) path loss is needed (with repeater gain being lower). The more the isolation requirement the more the spatial demands on the deployment. This drives site acquisition costs higher and limits the potential candidate selection.
    - Excessive noise contribution (from the repeater) introduced to system leading to degradation to network performance and capacity.
    - Network Management Integration. Some US Operators are challenged to integrate repeater alarming characteristics into existing Network Operations Center (NOC) monitoring capabilities. This results in repeater elements that are exposed to extended outage/degraded periods.
- Equipment Costs
  - There are a vast range of repeater solutions in the market today. There are two (2) distinct types: Off Air & Tethered Repeaters (i.e. Fiber Optically or coaxially transported Donor Signal).
    - Off Air are your more traditional type and range from $1k to $25k
    - Fiber Fed Repeaters can range from $10k to $50k (optical) and Coaxial (i.e. Bi-Directional Amplifier (BDA) can be $1k to $5k

cdma2000 Repeater Deployment Experiences

- Deployment Costs
  - There are basically four (4) types of labor costs that can be quantified in the deployment of wireless equipment. The typical repeater application has these same types of costs but with the majority of the savings coming from the equipment (i.e. repeater versus BTS). These four (4) cost areas are Cell Site Planning, Site Acquisition, Installation, and Commissioning.
  - Deployment labor costs can therefore be expected to be potentially 2/3 less than that of a traditional BTS.
- Subscriber Satisfaction
  - When applied properly the implementation of repeater solutions allow the operator the ability to address subscriber concerns quickly and effectively.
- Current Repeater Networks
  - Two (2) major Korean Wireless operators are estimated as having **700,000** active repeater devices which offer a ubiquitous service that could be considered unparalleled.

Conclusion

- Saving cost for the operator should be the top reason for developing a new standard for the MMR relay
  - Coverage extension
  - Capacity utilization improvement
    - Traditional wireless deployments have significant under-utilization throughout their networks. It is estimated that only 30% to 40% of the deployed assets are exceeding 50% of the available capacity. This is a significant amount of capital remaining idle and potentially never used.
    - The concept of a Greenfield DAS (i.e. Off-Air or Tethered) design initially could have been addressed much more effectively. Allocation of this excess capacity through this transport solution could mean millions of dollars of capital savings to the operators.
    - Endorsement of such concepts by major BTS vendors have not been seen and are not likely.
  - Dollar/dB improvement/pop is a potential metric that can be used to gauge and or justify the appropriate deployment solution.
- Performance enhancement should come second
- Labor costs associated with relay deployment cannot be ignored
- Combination of low-cost pico cells and relays provides an alternative cost-effective deployment strategy for operators

Backup Slides

Detailed Discussions on Repeater Deployment Applications

Urban Applications

In-building applications are an especially attractive setting for repeaters as distributed antenna systems. There are **four key service needs** that are driving the in-building need.

The first is the **extension of macro networks**. The extension here include coverage, hole fill and trouble spots, as well as large public buildings such as conference centers, stadium and airports.

The second one is **traffic relief**, including adding capacity inside and unloading the macro networks, as well as an alternative to adding cells in urban areas.

The repeater for wireless data on local area networks (LANs) is a third need. High-speed 3G data will travel at up to 2 Mbps, while advanced new systems will be needed to handle packet data on 2.5G digital cellular and PCS networks and the (IEEE) 802.11 wireless LAN 2.4GHz standard.

Finally, **wireless office systems** will also drive in-building applications in order to provide private-branch-exchange-like services, 'licensed services' for campus and macro networks (and cellular or PCS phones) and 'unlicensed services' for campus-only networks (involving special phones).

Reduce site costs in urban area

By co-deploying repeaters at the same sites with base stations, operators can use single-sector base stations and reap a corresponding backhaul saving while still maintaining a three sector 'footprint'.

Repeater Application for 3G Data Access

Repeaters that are engineered for operation in CDMA networks are tools for operators seeking to maximize high-data-rate coverage and to minimize capital and operating expenses.

Provide cost-effective high-data-rate coverage to rural areas

Although many operators will not place an immediate priority on deploying high-data-rate infrastructure in rural areas, eventually, rural inhabitants, SoHo's will need to be offered the same services as the urban population. Providing this service profitably, however, will be difficult due to the extremely low population density (roamers included). The use of repeaters offers one alternative for making high-data-rate rural coverage for operators most cost-effective.

Detailed Considerations for Repeater Deployment

Repeater Location Selection

System performance depends on the installation location, and the location must be selected carefully for the outdoor repeaters. The following factors must be considered when choosing a location and direction to install a repeater:

- Within the BTS cell radius, interference level should be as low as possible
- Choose an area where the BTS antenna and the coverage and donor antennas are in unobstructed paths, with an adequate signal strength (choose the direction where Ec/lo is at its maximum value)
- Choose repeater antennas with appropriate directivity and high front to back ratio to keep the repeater coverage and system noise level to a suitable standard
- Install coverage antenna so that desired isolation is obtained
- Use the minimum RF output, in order to minimize Soft Handoff Zones
- Choose a suitable repeater gain to minimize the effect of repeater noise on the donor BTS uplink

Antenna Choice and Positioning

It is very important to choose the proper antenna and position for an outdoor repeater. To choose an antenna with good performance, there has to be a fair isolation distance between the donor antenna and coverage antenna.

Antenna Isolation

Antenna isolation refers to the phenomenon of the signal strength from the Rx BTS and amplified donor signal reentering the donor through the coverage antenna. To prevent repeater oscillation, the BTS Rx level must be higher than the repeater Rx level by approximately 10 to 15dB.

Antenna Isolation = RSSI signal from BTS – RSSI signal from repeater + 15 dB

Repeater Noise Effect Analysis

Repeater noise analysis is extremely important. To guarantee the best system performance, suitable parameter settings are necessary. Whether or not the repeater relays the signal from the subscriber to the BTS, all internal and external noise factors are transmitted to the BTS. This basically raises the noise level of the BTS and reduces the coverage and the efficiency of the network.

cdma2000 Repeater Deployment Cost Comparison

Unit : US $

Items	Details	BTS	Repeater	Reference
Equipments	BTS or Repeater	215,000	20,000	+ + +
	MSC/BSC/Software (per BTS)	20,000	0	+ +
	Antenna System	15,000	10,000	+
	Others (Backup Battery, E1/T1 Line, etc)	10,000	3,000	+
Maintenance	Rental Cost for Site	12,000	6,000	+
	Maintenance/Repair	50,000	1,000	+ +
	Rental Cost for E1/T1	6,000	0	+
	Others (Electric charges, Tax, Etc)	3,300	250	+
Others	**Site Acquisition**	10,000	5,000	+
	Cell Planning /Commissioning	10,000	10,000	
	Installation	40,000	5,000	+ +
Total		391,300	60,250	Δ331,050

- The example above is the typical example for BTS and Repeater cost comparison. The actual cost may differ with the BTS type or Repeater type.