HUGHES
NETWORK SYSTEMS

5th RUSSIAN COMMUNICATIONS FORUM

2 & 3G Cellular Backhaul: Future Proof Approach

November, 2004

Broadband Wireless Communications Company

HUGHES NETWORK SYSTEMS

- 2003 Sales: $1.3B
- 2,750 employees
- Based in Germantown, MD, U.S.A.
- More than 30 offices, design centers, and manufacturing facilities worldwide
- Global leader in wireless communications - systems everywhere in the world
- Broadband Everywhere™ satellite transmission services

Cellular Services Evolution

- **2G services:**
  - Low-rate voice
  - SMS/text message
  - Circuit-switched data ~64 kbps
- **Initial 3G services:**
  - Packet data 256-512 kbps per user
  - Constant bit rate or best efforts
- **Future 3G services:**
  - 1,000 to 2,000 kbps per user
  - Pricing based on QOS – committed rate, minimum committed rate, maximum burst rate, best efforts, etc.

Transmission Network Evolution

	Cell Site Interface	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GSM	E1/T1 TDM										
WCDMA											
R'99 - Rel. 4	ATM on E1 IMA or STM-1										
UMTS Rel. 5	IP/Ethernet										
CDMA 2000											
CDMA One	E1/T1 TDM										
EV-DO	IP/Ethernet										
EV-DV	IP/Ethernet										

Packet (ATM or IP) networks will predominate new deployments in 2-3 years

Backhaul Capacity Growth

- **Today's GSM/CDMA networks fit 90-150 voice users on an E1 backhaul link**
- **Initial 3G data rates (256-384 kbps) accommodate only 4-5 users per E1 backhaul link**

Per-user cell backhaul requirement increases ~2,400%

- **Transmission/backhaul cost ~15-25% of total network cost**
- **Access (cell site link) ~85-95% of transmission cost**
- **Access link ~15% of total network cost**

Network cost per user increases x?% in initial 3G

Cellular Backhaul Options

- **Lease Lines**
  - High Cost
  - Long Provision Times
- **PTP Microwave**
  - Relative High Cost
- **Fiber Optic**
  - Availability
  - Cost
- **VSAT**
  - Unique situations

Emerging Solution - PMP

- **Wireless backhaul solution:**
  - **Point-to-multipoint (PMP) architecture reduces cost, concentrates ATM / IP packet data**
  - **Supports TDM, ATM, and IP interfaces for ease of migration**
  - **26-28 GHz frequency bands required for high capacity per cell site (spectrum allocated in 3.5/10.5 GHz bands not adequate to support >2 Mbps per cell site)**

Why Deploy LMDS?

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- **Operators must focus on profitability by:**
  - **Optimizing invested capital**
  - **Building *multi-purpose platforms* to capitalize on *converging services* rather than deploying single-purpose networks**
  - **Increasing the per subscriber revenues**
- **LMDS can help achieve these goals:**
  - ***Quick time to market:*** **wireless means minimal planning, minimal right-of-way issues, no need to predict demand; LMDS can be re-deployed**
  - ***Converged services / more revenues:*** **One platform, many applications means consolidation of different access technologies and hence lower overall cost for the operator**
  - ***Expanded broadband service area:*** **LMDS extends the fiber footprint 3-5 km to either side of the fiber, encompassing many more buildings which can be served with broadband services.**

What is LMDS?

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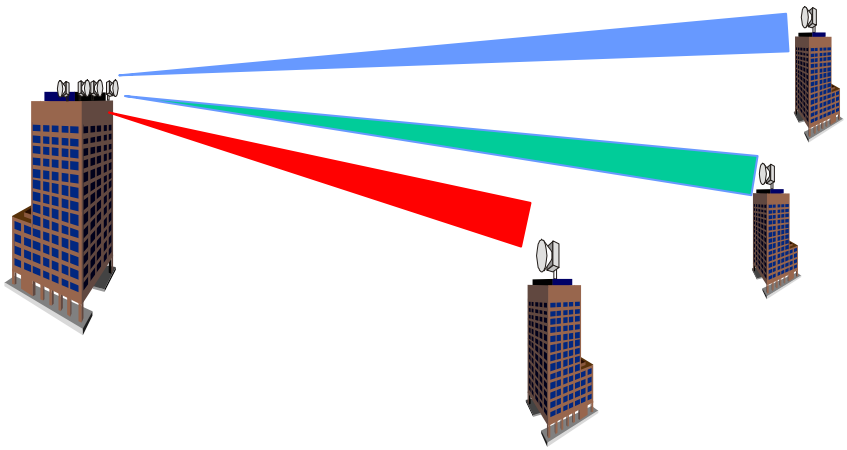
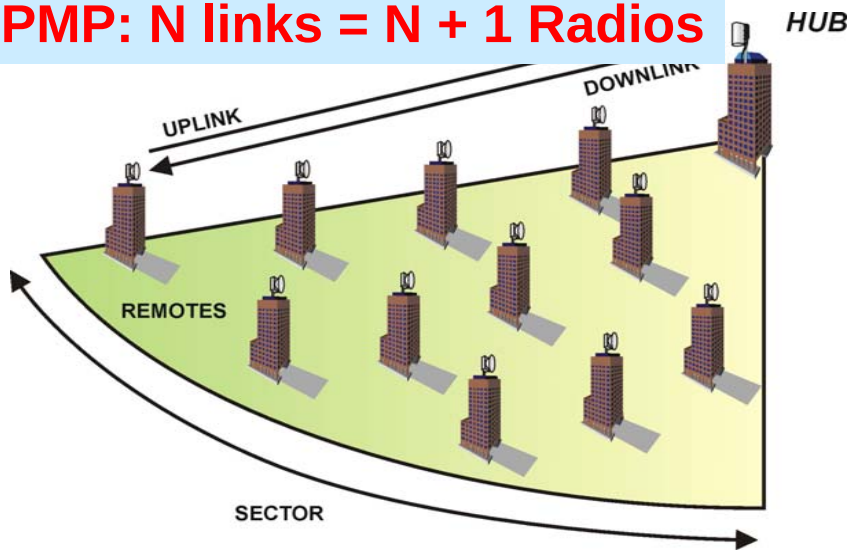
- **LMDS = Local Multipoint Distribution Service, a multi-purpose platform for last mile access solution**
  - Connecting GSM / CDMA / 3G cell sites
  - Connecting WiFi hot spot sites
  - Basic telephone services such as voice and ISP
  - Broadband services such as fractional E1, multiple E1, LAN, and high-speed DSL
- **LMDS uses Point to Multipoint (PMP) architecture which requires fewer radios than PTP**

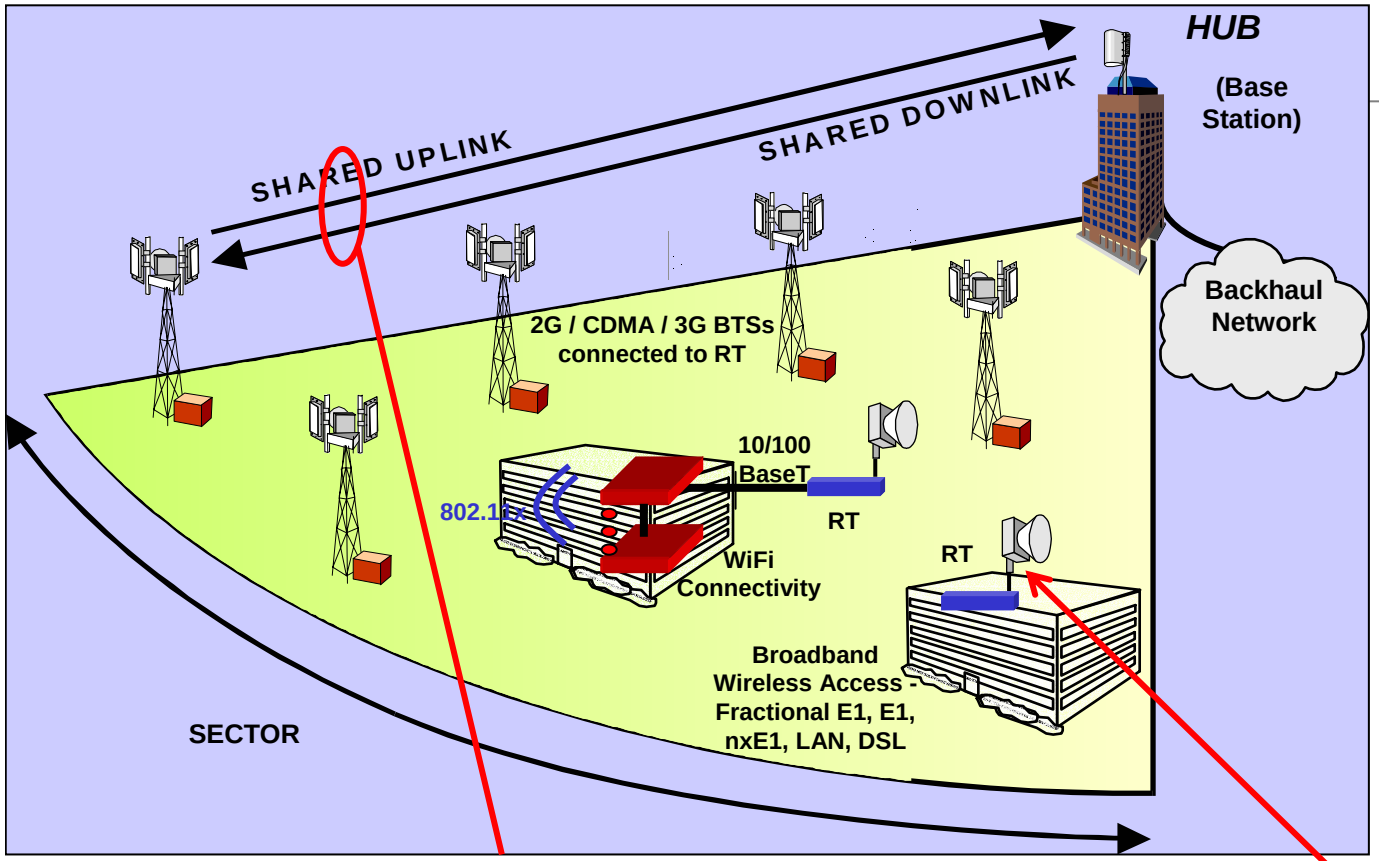
PTP: N links = 2 x N Radios



PMP: N links = N + 1 Radios



LMDS Overview



Hub Specifications:

- Scalable, sector by sector growth
- nxE1 (TDM or ATM), E3 (ATM), STM-1 (ATM), LAN interfaces
- Hub should also work in PtP mode
- 90º, 180º, and 360º sectors

Radio Specifications:

- ETSI 26 & 28 GHz
- Access: FDD/TDMA
- 14 MHz RF Channel with 15 - 30 Mbps
- Range: 3 - 5 km or more
- Multiple Modulation
- 64 RTs per RF Channel

Remote interfaces:

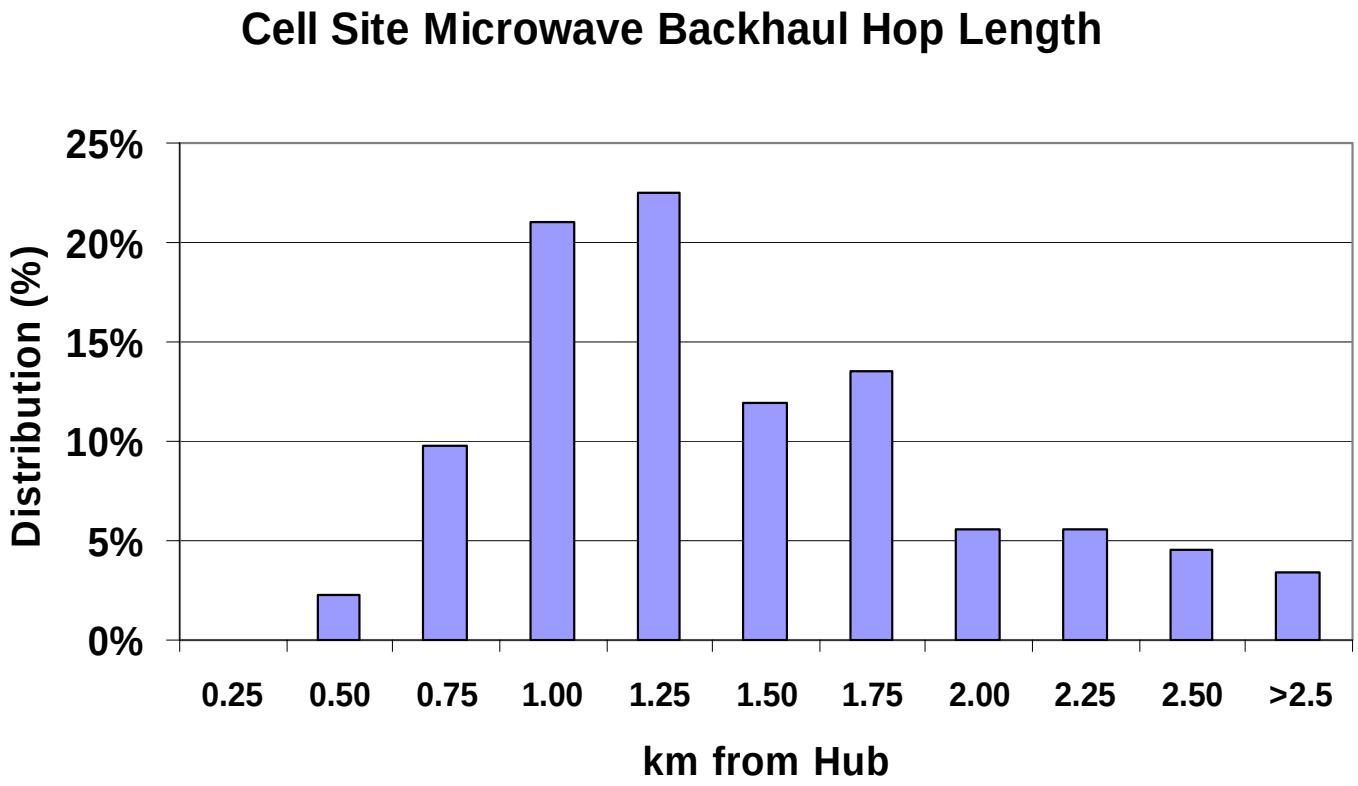
- *Physical: E1, STM-1, LAN*
- *Traffic: TDM, ATM, ATM IMA, IP*

Typical PMP Range

Availability	QPSK	16-QAM
26 GHz, Rain Zone K (42 mm hr)		
99.99%	4.5 km	3.0 km
99.995%	3.7 km	2.5 km
99.999%	2.4 km	1.7 km
26 GHz, Rain Zone N (95 mm / hr)		
99.99%	2.6 km	1.8 km
99.995%	2.0 km	1.5 km
99.999%	1.3 km	1.0 km
26 GHz, Rain Zone P (145 mm / hr)		
99.99%	2.1 km	1.4 km
99.995%	1.6 km	1.1 km
99.999%	1.0 km	0.7 km
Note: 4-Sector Hub Site with a BER of 1E-08		

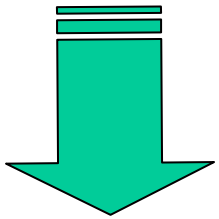
LMDS Range

- **LMDS 2-3 km range is consistent with average length of microwave links used for cell site backhaul**



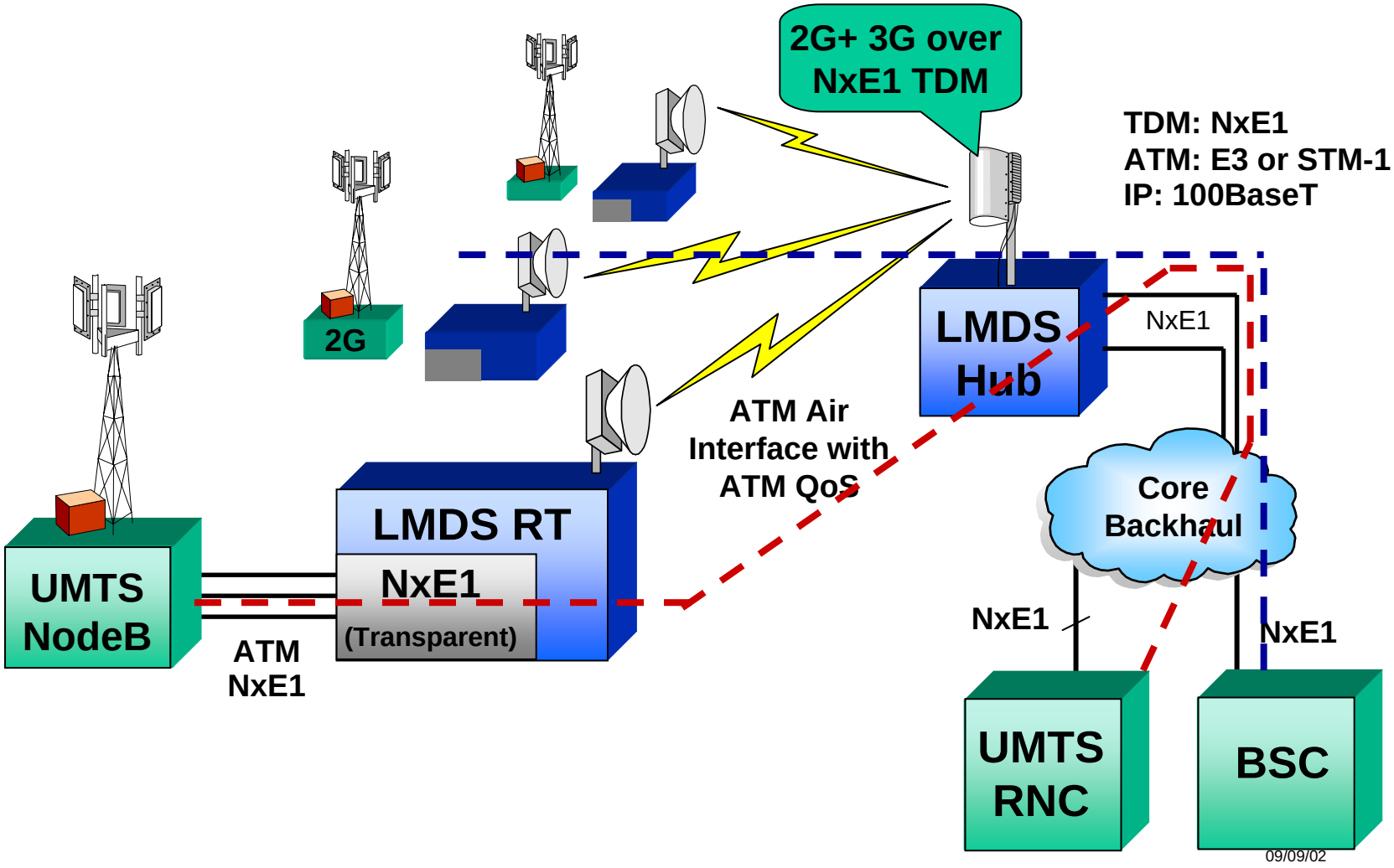
LMDS Applications

- **Cell site connectivity**
  - GSM and CDMA: E1, or nxE1 TDM
  - UMTS (3G): nxE1 ATM
  - Near future: IP
- **WiFi hotspot connectivity**
  - 10/100BaseT LAN port
- **Telephone / Data / DSL services**
  - Telephone, fax, dial-up internet access, DSLAM
- **Broadband services**
  - Fractional E1, E1, nxE1
  - DSL, BoPL

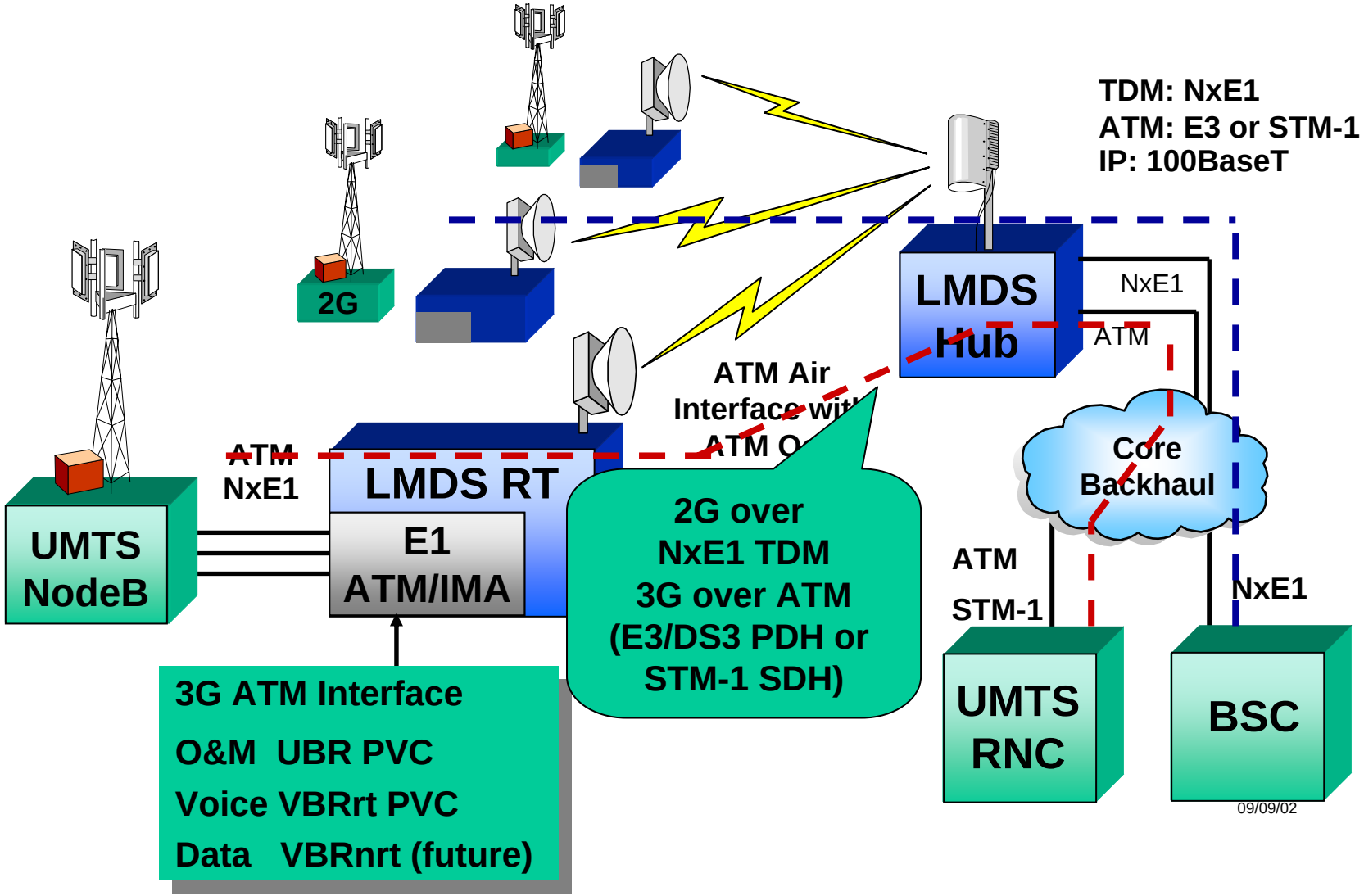


LMDS becomes a Revenue Generator!

LMDS Application
2G + 3G Backhaul using TDM

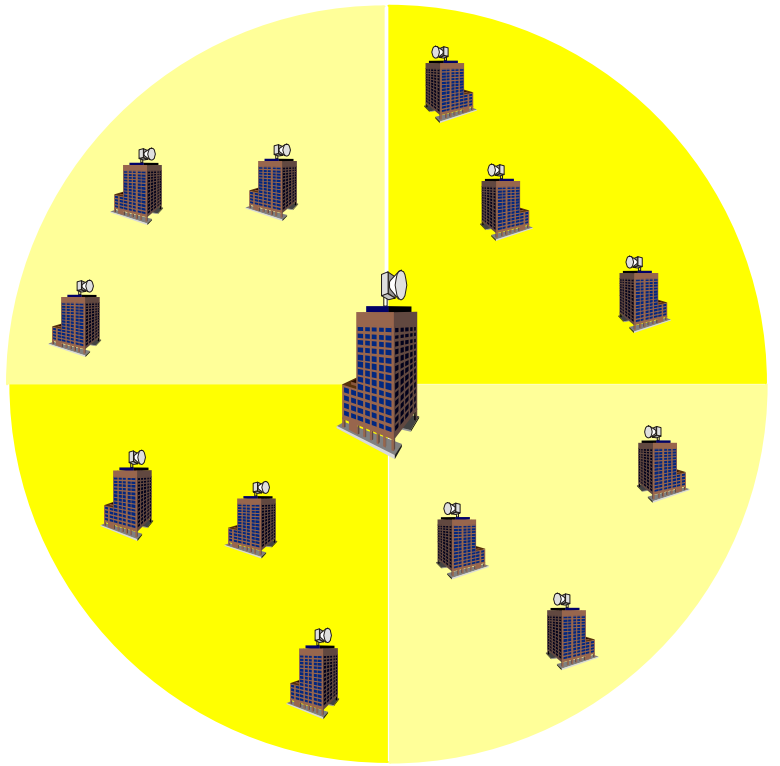


LMDS Application
2G + 3G Backhaul using ATM



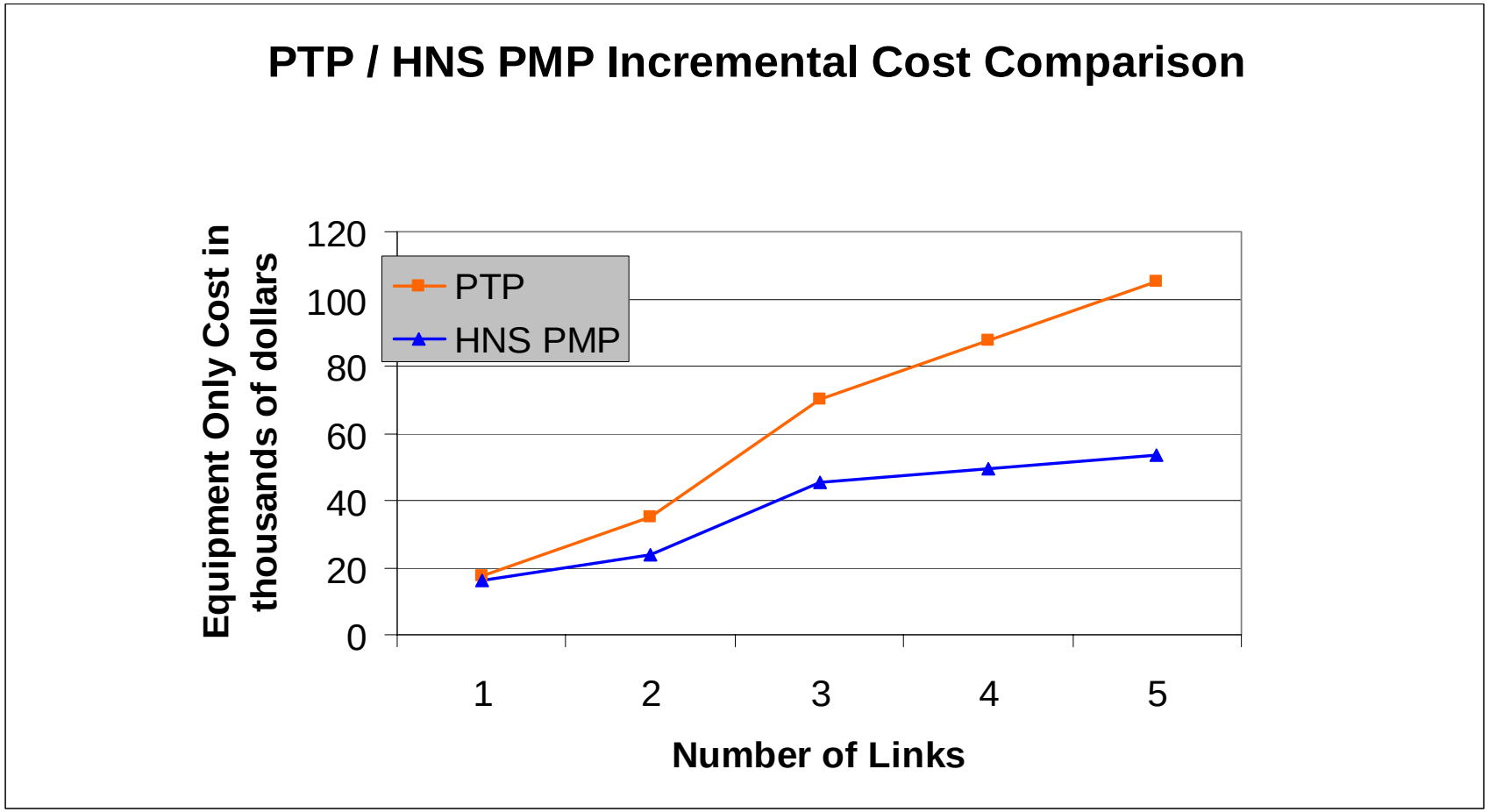
PMP Cost Advantage

- **Access transmission node (hub) serving 12 cell sites needs 24 point-to-point (PTP) microwave radios vs. 16 PMP radios (12 RTs + 4 Sectors)**
- **Significant reduction in initial capital cost as well as cost of installation, permits, spares, maintenance, etc.**



Typical PMP node coverage
4-7 km diameter

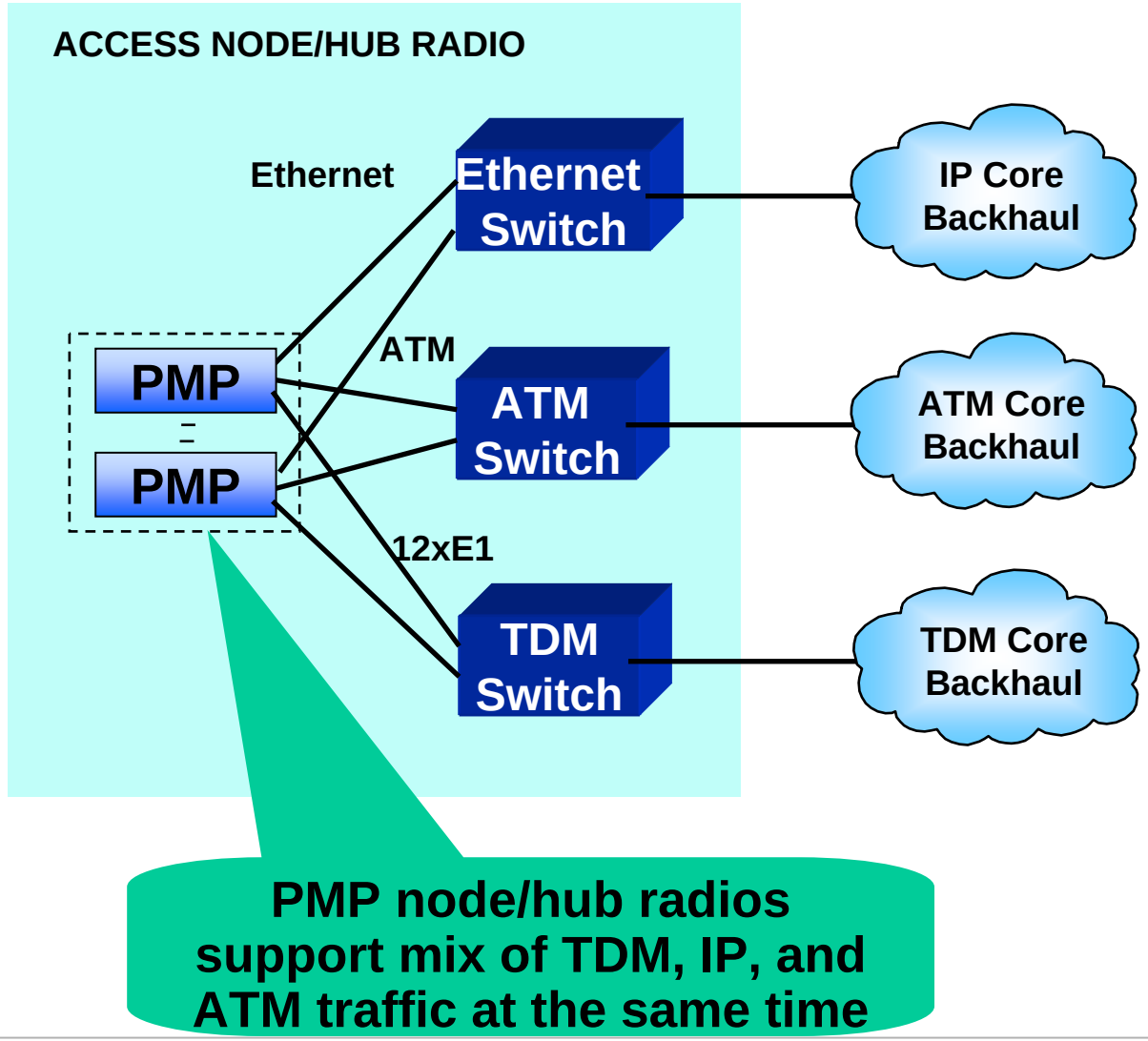
Typical PMP Savings vs. PTP Microwave Backhaul



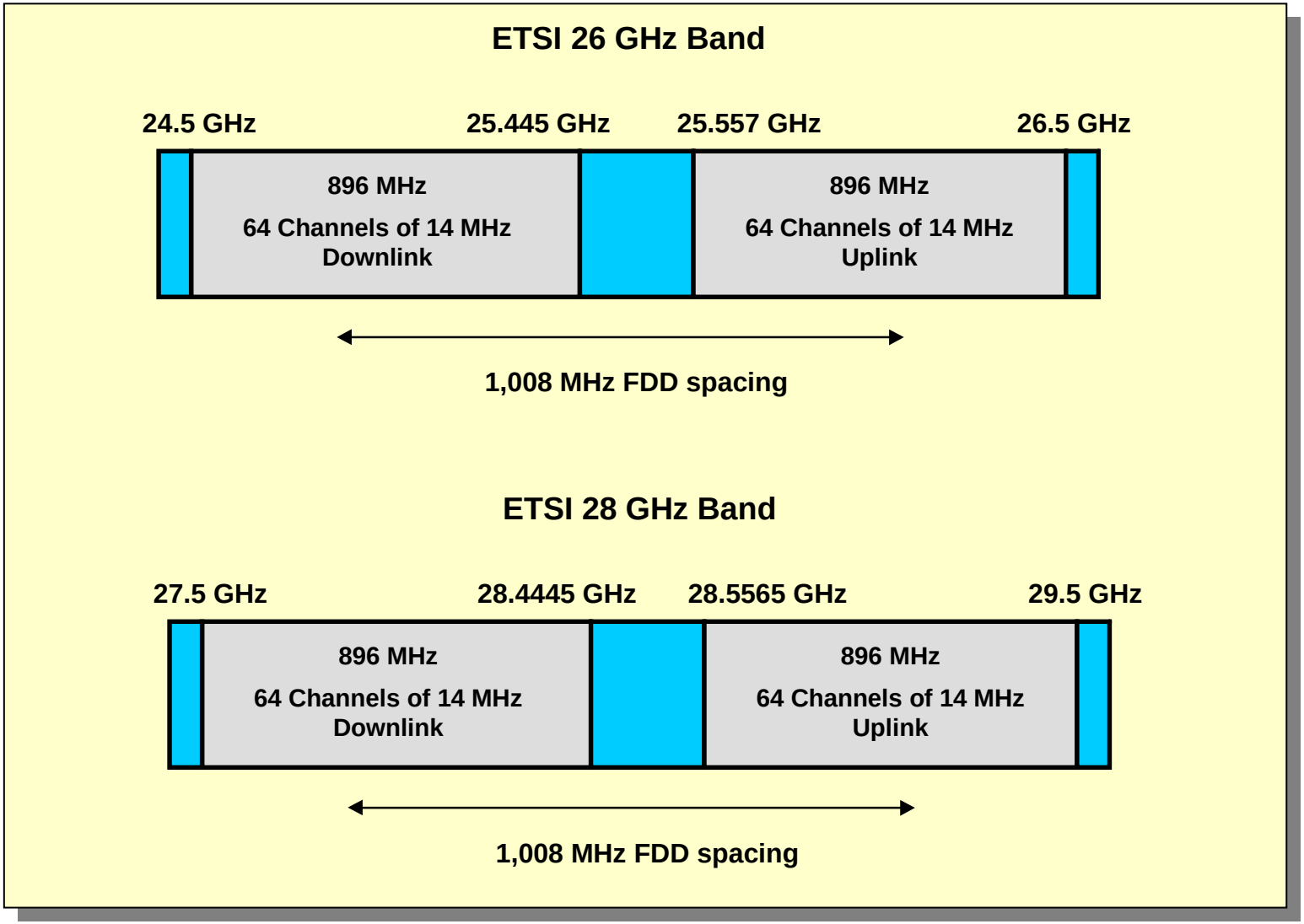
AIReach Savings:	9%	31%	35%	43%	49%

**3 links and above are redundant for both PTP and PMP*

PMP Multi-Protocol Support



LMDS ETSI 26 / 28 GHz Channel Plans



PMP Remote Terminal

- **Operational advantages**
  - More spectrum efficient using QPSK/16-QAM modulation
  - Interfaces and payload reconfigurable remotely
  - Frequency agile – new frequency plan downloadable from EMS
  - 1:1 redundancy option
  - Front access
- **Physical interface options**
  - 4-12xE1/T1
  - 2x10/100BaseT
  - STM-1 ATM
  - Traffic migration from TDM to ATM to IP without platform change

9400 Hub Terminal

High Performance and High Functionality

- **Outstanding operational performance**
  - **TDMA Multi-Mode Modulation: QPSK and 16 QAM**
    - **30 Mbps payload (2 bit/Hz)**
- **Physical interfaces**
  - **a) STM-1/OC3c ATM**
  - **b) 12xE1 TDM + 100BaseT**
  - **c) 100BaseT only**
- **Frequency Bands**
  - **ETSI 26 GHz**
  - **ETSI 28GHz**
- **Scalable**
  - **Single sector (one HT)**
  - **Large Hub**
- **Frequency change 'on the fly'**

HNS PMP Deployments for Cell Backhaul

- **Vodafone Italy**
  - GSM & 3G cell site links
- **WIND Italy**
  - GSM & 3G links
- **Era Poland (T-Mobile Poland)**
  - GSM, 3G, and Wi-Fi backhaul
- **China**
  - China Unicom: GSM and Wi-Fi backhaul
  - China Mobile GSM backhaul
- **Trials with two major carriers in USA under new FCC spectrum sub-leasing policy**

Conclusion – 2 & 3G Backhaul

- **No One Perfect Solution for all Backhaul Application**
  - Lease Lines
  - Traditional PTP radios
  - Fiber Optics
  - VSAT
  - LMDS / PMP ***
- **Key Choice Factors:**
  - Capital Expenditure
  - Flexibility
  - Maintenance
  - Provision Time

***Emerging Advantageous Future Proof Option - LMDS / PMP approach !!!

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