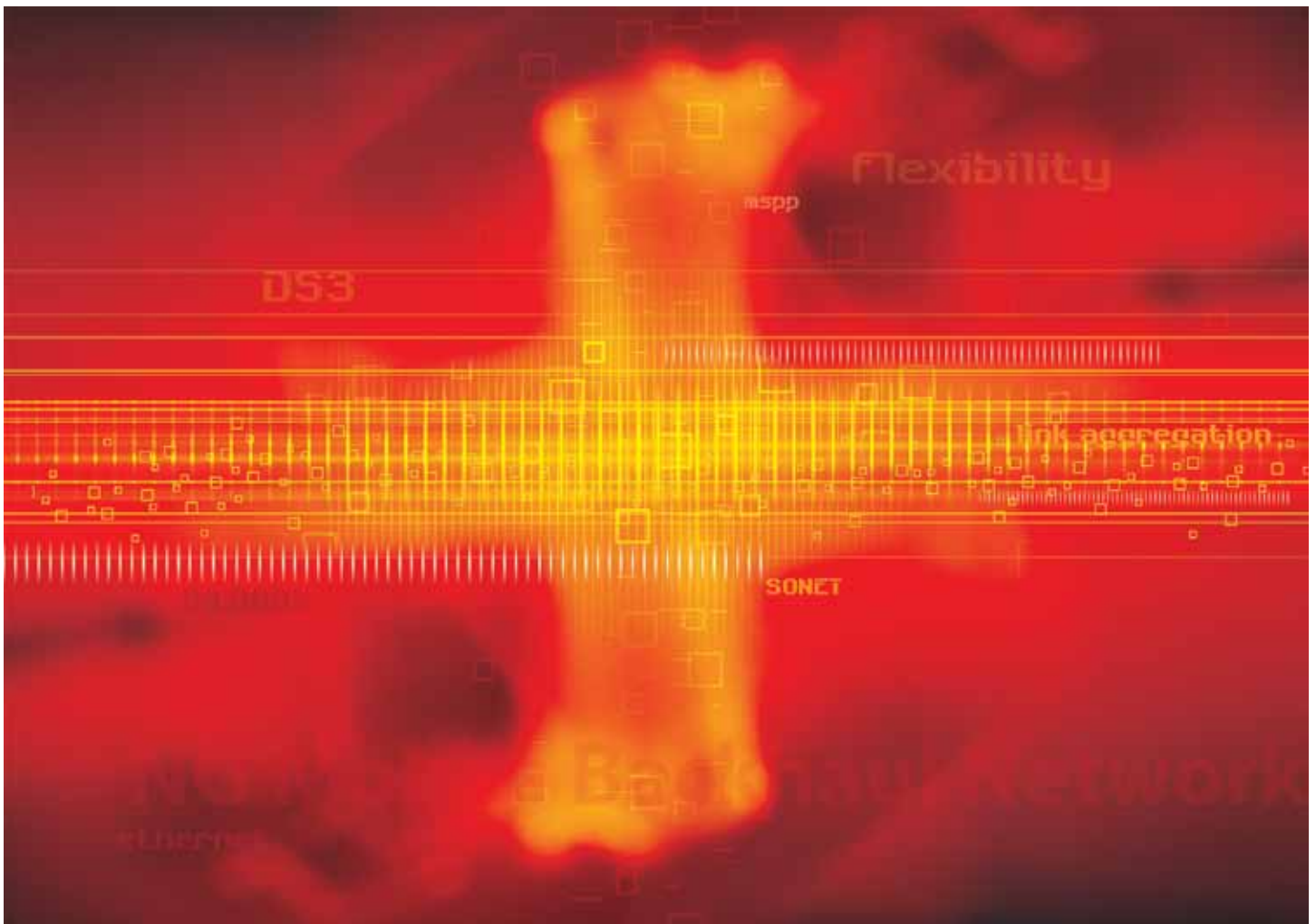# FUJITSU

Achieving Smooth Migration to a Next-Generation Mobile Backhaul Network

Current 2G and 3G fiber-fed mobile backhaul networks use highly reliable SONET network elements to transport DS1 services from cell towers to MSCs effectively. Service providers are using OC-3 and OC-12 circuits to interconnect multiple cell towers in a UPSR, providing non-service-affecting site scalability and survivability.
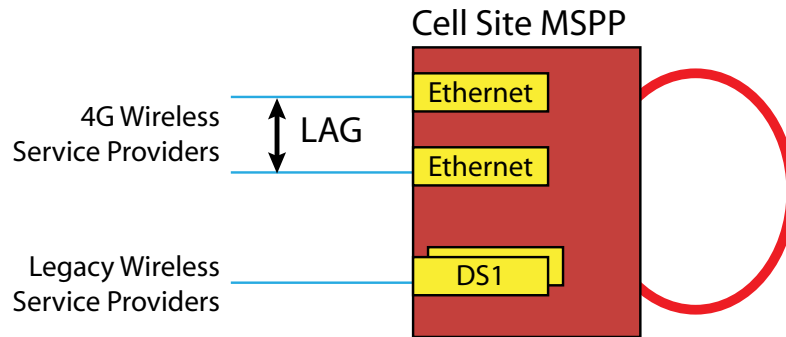
Network element hardware and power sources are fully redundant. Network element power supplies are distributed on individual cards and fed over redundant power buses to eliminate any single point of failure, yielding 99.999% availability. Scaling the cell tower access capacity adds DS1s until an economical breakpoint is reached relative to DS3 tariff pricing. Based on DS3 tariffs, a crossover point of five to seven DS1s justifies a DS3 lease. To facilitate DS3 service access, service providers will add M13 multiplexer functionality to the optical multiplexer using an external M13 network element or, if using an advanced MSPP, will install a transmux card emulating the M13.
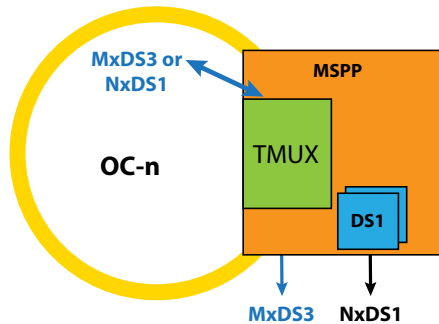
**Figure 1: Transmux DS1 Grooming to DS3 Over OC-n**

The transmux card grooms the DS1s into a DS3 at the access point, satisfying the DS3 tariff while providing an economic advantage of 28 DS1 capacity for the price of five to seven. Once groomed, an advanced MSPP will transport the DS3 directly over the system bus to the OC-n optics, further saving capital expense and additional equipment to break out and remultiplex the DS3.

As 4G technology becomes available, wireless service providers will upgrade their network for WiMAX and LTE. Use of 4G radios at cell tower sites requires a transition from DS1 to Ethernet interfaces for backhaul. OC-n rates at cell sites typically scale to OC-48 once Ethernet traffic is added. Wireless service providers will transition their equipment over the course of the next several years. Therefore, the wireline service providers must offer both DS1service for legacy providers and service-aware Ethernet for WiMAX/LTE upgraded providers.

FUJITSU NETWORK COMMUNICATIONS INC.
2801 Telecom Parkway, Richardson, Texas 75082-3515
Telephone: (972) 690-6000
(800) 777-FAST (U.S.)
us.fujitsu.com/telecom

For your convenience, a list of acronyms can be found at the end of this document.

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Figure 2: MSPP at Cell Site with LAG and DS1

Over time, DS1 demand will convert to Ethernet, but that transition period is unclear. To reduce risk, provide flexibility and maintain installed base investment, wireline service providers will implement a platform capable of supporting both traditional TDM and service-aware Ethernet through scaling, using GFP-F [1] plug-in cards as needed. Otherwise, wireline service providers must install new Ethernet-centric equipment at cell towers where footprint is at a premium, increasing both capital and operational expenses. The 4G cell site contains a mix of CIR and EIR services and signals to be transported to the MSC. These services may include VoIP, streaming video, Internet data and telemetry signals. Wireless service providers may use an L2A [2] to efficiently consolidate these signals at the cell site using various classes of service and statistical multiplexing. The consolidated L2A is the service port to be backhauled. Since Ethernet traffic at the cell site is policed using the L2A, the MSPP service port will be all CIR service and transported over an EVC. The EVC may be duplicated by the wireless service provider at the L2A. The duplicated EVCs are diversely mapped across the WAN facility by the wireline service provider and service multiplexed at the MSC.
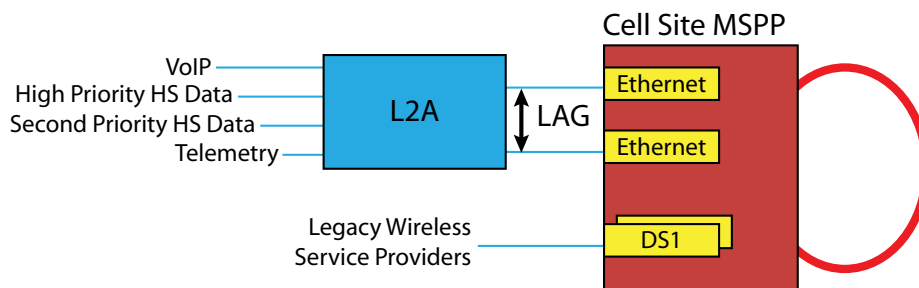
Figure 3: Cell Site MSPP with L2A Interconnect

The MSPP service port interface should offer rate-limiting CIR to backhaul the L2A traffic efficiently. Maintaining 99.999% reliability for Ethernet service at the cell site requires a similar level of redundancy to the DS1 hardware method. Use of 802.3ad [3] LAG between the L2A and two service cards within the micro packet-OTN ensures Ethernet resiliency, effectively providing a 1:1 hardware redundancy, as illustrated in Figure 3. To ensure maximum end-to-end performance over the WAN, Connection-Oriented Ethernet (COE) techniques are used within the MSPP or Micro Packet ONP. COE offers deterministic operation, consistently delivering Ethernet services with the lowest latency, jitter and frame loss. Ethernet service delivered using COE provides the same performance whether the network has few or many network elements and regardless of WAN facility fault protection switching.

Maintaining SONET performance at brownfield sites provides carrier-class service capabilities in the access network. Legacy TDM services are undisturbed, whereas circuit emulation using current techniques over Layer 2/Layer 3 facilities oversubscribes network bandwidth and has unpredictably high latency and jitter. Ethernet CIR traffic over SONET provides COE operation using GFP-F, and realizes one-way latency in the order of 1.3 milliseconds (worst case) using jumbo frames, as shown in Figure 4. Jitter and frame loss are less than 125 microseconds and are therefore nonexistent, due to the predictable time-based nature of SONET.

Interface	Frame Size	Average Latency (ms)
10/100Base-T	64	0.04
10/100Base-T	192	0.06
10/100Base-T	320	0.08
10/100Base-T	1600	0.25
10/100Base-T	9600	1.32
100Base-X	64	0.04
100Base-X	192	0.06
100Base-X	320	0.07
100Base-X	1600	0.24
100Base-X	9600	1.31
GigE	64	0.04
GigE	192	0.04
GigE	320	0.04
GigE	1600	0.06
GigE	9600	0.19

Figure 4: Table of Latency Rates for Ethernet CIR Traffic over SONET using GFP-F

Greenfield networks used for 4G service use micro Packet ONPs at the cell site to transport data services using COE over OC-48, point-to-point LAG or G.8031 VLAN protected ring topologies up to 10 GbE WAN facilities. COE over OC-48 offers almost a 2.5 bandwidth increase over GbE access multiplexers.
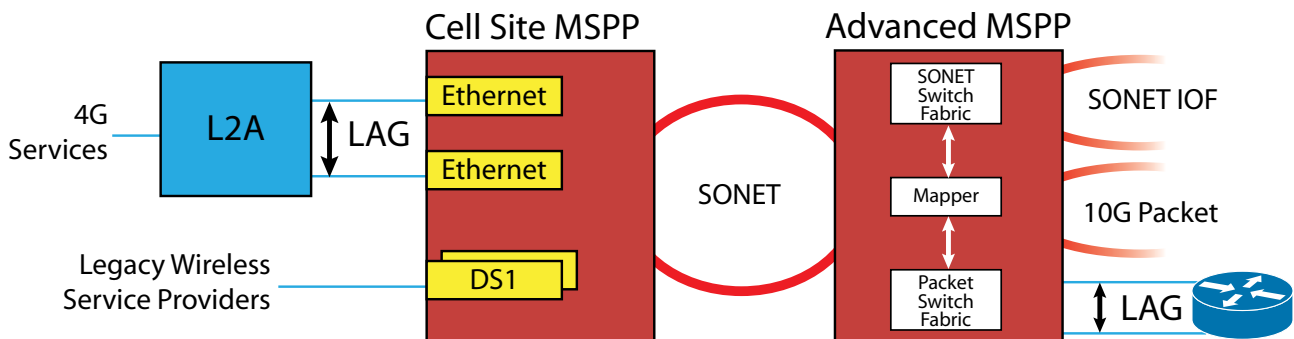
At the MSC, the MSPP TDM traffic is aggregated to a DCS using DS3 or OC-n interconnects. Ethernet traffic is service-multiplexed [3] providing EVPL [4] connectivity as per MEF-9 from the cell towers. Maintaining multi-customer service separation and preventing multi-tag duplication in mixed in- and out-of-franchise networks is solved using 802.1Q [4] VLAN tagging offering pushed, popped or swapped tag treatment.

Odd and even EVCs are service multiplexed on separate ports in dual EVC architectures. These separate service multiplexed EVC ports presented from the wireline service provides Packet ONP to the wireless service provider using 802.3ad LAG between two cards of the Packet ONP maintaining high service reliability just as is used at cell sites.
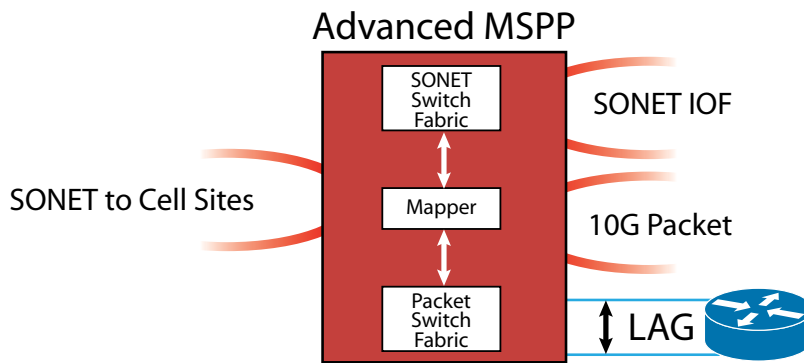
Figure 5: Advanced MSPP Dual Fabric and Mapper

Packet ONPs at the hub and MSC sites have both TDM and packet switch fabric to optimize traffic treatment with mapping processors to translate between the two. The mapping processor provides a smooth transition for brownfield sites using SONET to and from packet facilities. This smooth transition allows Packet ONPs to operate in a SONET network and terminate packet traffic, as well as forwarding to higher-order networks using 10 Gbps facilities. The higher-order network provision enables gateway operation for future packet-based network applications.

Figure 6: Next-Generation Mobile Backhaul Network

FUJITSU NETWORK COMMUNICATIONS INC.
2801 Telecom Parkway, Richardson, Texas 75082-3515
Telephone: (972) 690-6000
(800) 777-FAST (U.S.)
us.fujitsu.com/telecom

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Summary

Packet ONPs offer multiservice operation to achieve 99.999% service availability for COE and TDM traffic backhauling, while providing solutions for greenfield and brownfield backhaul applications. Smooth transition from legacy SONET to packet functionality enables service providers to reuse legacy networks to offer advanced data and maintain original TDM services. Packet ONPs with multiple switch fabrics optimize operations for SONET and packet with mapping translation between them. These architectures offer seamless migration from present-mode SONET to packet while preserving installed-base investments. Access networks using Packet ONPs using GbE, OC-48 or 10 GbE for point-to-point or ring protection offer in-service scaling to higher speed rates in an all industrial grade, temperature-hardened "five-nines" platform. COE service delivery offers easy provisioning and deterministic low latency/jitter/frame loss performance regardless of the number of network elements or whether a protection switch occurred. Finally, centralized network management of the backhaul network simplifies operation and expedites fault mitigation.

References:

[1] GFP-F Generic Framing Procedure (GFP), ITU-T G.7041

[2] IEEE 802.3ad; Layer 2 aggregator

[3] IEEE 802.3ad Link Aggregation

[4] Metro Ethernet Forum; MEF-9; EVPL Ethernet Virtual Private Line; service multiplexed virtual connection

Term	Definition
4G	Fourth-generation wireless technology
CIR	Committed Information Rate
DCS	Digital Cross-connect System
EIR	Excess Information Rate
EVPL	Ethernet Virtual Private Line
GFP-F	Frame-based Generic Framing Procedure
GigE	Gigabit Ethernet
IEEE	Institute of Electrical and Electronic Engineers
IOF	Interoffice Facility
L2A	Layer 2 Aggregation
LAG	Link Aggregation

Term	Definition
LTE	Long-Term Evolution
MEF	Metro Ethernet Forum
MSC	Mobile Switching Center
MSPP	Multiservice Provisioning Platform
SLA	Service Level Agreement
SONET	Synchronous Optical Networking
TDM	Time-Division Multiplexing
UPSR	Unidirectional Path Switched Ring
VLAN	Virtual Local Area Network
VoIP	Voice over IP

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2801 Telecom Parkway, Richardson, Texas 75082-3515
Telephone: (972) 690-6000
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us.fujitsu.com/telecom

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