A future-proof UMTS core for today’s mobile networks
Implementing the Marconi BXR™-48000 in the UMTS core network
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Introduction

Universal Mobile Telecommunication System (UMTS) technology has the potential to dominate the mobile broadband service market. The vision to move from a telephone-centric to a third-generation (3G) multimedia mobile infrastructure, however, creates challenges for network architectures, standards, and technologies. These challenges can directly translate into added risk and costs for UMTS providers.

The UMTS solution from Marconi provides a low-risk and cost-effective platform (in terms of CapEx and OpEx) for both the short and long term. The Marconi solution assists mobile providers in building and evolving their UMTS core networks and UMTS Terrestrial Radio Access Network (UTRAN) infrastructure in size, functionality, and capabilities over time, supporting existing services and enabling new, profitable 3G packet-centric telecommunication services.

The Marconi family of broadband switches and switch routers — including BXR™-48000, ASX®-4000, ASX-4000M, TNX™-1100, and TNX-210, which provide 480 Gbps, 40 Gbps, 10 Gbps, and 2.5 Gbps of switching capacity, respectively — represents a common packet-switching transport platform for both the UMTS core network and the UTRAN. Marconi switches and switch routers enable a unified, converged network architecture that significantly reduces complexity, CapEx, and OpEx.

The Marconi BXR-48000 core switch router is the ideal foundation for the UMTS core network. The BXR-48000 fulfills or exceeds the reliability, scalability, predictability, and versatility requirements expected from any telecommunications network and, therefore, from an “IP-centric” UMTS network infrastructure.

The BXR-48000 core switch router gives UMTS rollouts the scalability and flexibility to operate with equal efficiency in ATM and IP network cores. Utilizing the BXR-48000 to build the UMTS core ensures high-performance ATM today and IP/MPLS tomorrow — without new chassis, forklift upgrades, or complex migration strategies.

UMTS technology options

The 3rd Generation Partnership Project (3GPP) — the standards body for UMTS technology — specifies three unique core infrastructure options: Release 99, Release 4, and Release 5 (R99, R4, and R5). The R99 and R4 recommendations specify Asynchronous Transfer Mode (ATM) as the preferred transport for voice and data services. R5 includes IP and ATM as design options for the UTRAN and core infrastructure. For the foreseeable future, controlling the risks and costs associated with the UMTS R99 to R5 evolution will be key to ensuring customer satisfaction and profitability.

ATM to IP/MPLS

High-speed data transport and Internet access will bring much-needed high-margin services to increasingly lower-margin voice revenues. Other high-margin 3G services will include telephony, video, audio, and other deterministic data and multimedia services. A common requirement for these time-sensitive services is to control the end-to-end network bandwidth, delay, and jitter. ATM was chosen by the 3GPP as the preferred standard for this very type of mixed media transport due to its well-known capability of supporting both real-time services and best-effort data transport fairly and reliably.

Because connectionless hop-by-hop IP routing does not support any of the control mechanisms used by ATM for traffic management and Quality of Service (QoS), connection-oriented Multiprotocol Label Switching (MPLS) was included in the R5 recommendations as an optional technology for the converged UMTS core network. MPLS-based traffic management and traffic engineering are supposed to introduce carrier-class service reliability and predictability to IP. However, MPLS standards are still evolving and need further refinement to ensure vendor interoperability with respect to service contract definition and the parameters each device requires to conform to that definition.

Moreover, in many cases MPLS functionalities are added to connectionless IP routers via software-only upgrades. These upgraded routers do not provide the same levels of traffic management and traffic engineering in hardware and software as those that have come to be expected from the best ATM implementations, such as per-label switched path (LSP) policing, queuing, shaping, and scheduling; per-class load balancing; source and destination protection; LSP fast reroute with high connection rates; and prioritized LSP reroutes.

Marconi brings our experience in connection-oriented routing, signaling, traffic management, and traffic engineering to MPLS. During this transition phase, our integrated switch router implementation is the lowest-risk choice for the UMTS core network. With its support of scalable, end-to-end, point-and-click provisioning of predictable ATM, IP, and MPLS services, the BXR-48000 minimizes operational costs, processes, and provisioning times. In addition, the BXR-48000’s hardware redundancy and software-based network resiliency bring unrivaled reliability to the UMTS core network.
Lowest-risk choice for a smooth UMTS network evolution

As UMTS standards and implementations mature, the UMTS infrastructure will need to evolve, from 3GPP R99 to R4, R5, and beyond. Marconi broadband switch routers, particularly the BXR-48000, operate with equal efficiency and capability as an ATM-only switch, in the dual role of an ATM switch and an IP/MPLS router (operational in both the ATM and MPLS control planes), and as an IP/MPLS-only router. Marconi capabilities in connection-oriented, capacity-aware, and congestion-aware MPLS routing and signaling support traditional best-effort IP routing for services such as voice or real-time, delay-intolerant data services. Consumers buying 3G phones anticipate — and expect — delivery of real-time data services to their handsets, and mobile operators who wish to be profitable must meet their customers' expectations. The BXR-48000 has the capability to support the core functions of R99 infrastructures through R5 deployments — and beyond.

Opportunity for UMTS core network simplification

A UMTS core using a single common platform would be significantly less complex and realize reduced CapEx and OpEx. But since R99 recommends ATM transport, and R5 permits the use of IP/MPLS in the network core, mobile operators are faced with a choice: do they build for today's revenues or for tomorrow's higher-margin services? The optimal solution would be to build a network core capable of both ATM and IP/MPLS transport but is not subject to the performance penalties associated with using routers in ATM networks or ATM switches in IP/MPLS routed backbones.

The R5 release specifies where ATM and IP/MPLS will be deployed in UMTS networks. ATM switching can be used to terminate ATM-based traffic from the following interfaces/links. Figure 1 illustrates the locations of these links in the UTRAN and UMTS core.

- \( I_{ub} \)
- \( I_{ur} \)
- \( I_{u-CS} \)
- \( I_{u-PS} \)

Figure 1 – Links in the UTRAN and UMTS core network

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1 the \( I_u \) interface is specified at the boundary between the core network and UTRAN.
2 The link between radio network controllers (RNCs)
3 Specifying circuit switching, this is the link between the RNC and the MSC for voice traffic.
4 Specifying packet switching, this is the link between the RNC and SGSN for packet data.
IP routing is the only option available as part of the R5 recommendations. IP will play a role in the network core for
- interconnecting the RNC to the Internet-facing GGSN and SGSN nodes,
- Iu-PS traffic (3GPP Release 5), and
- optional IP-based traffic as specified in 3GPP R5 and later.

When deployed in the UMTS network core, the Marconi BXR-48000, with its dual ATM and MPLS control planes, supersedes the heterogeneous architecture consisting of an ATM switch and IP router. The BXR-48000 reduces hardware requirements and creates a core network, extending the Marconi UMTS solution end-to-end from Node B — the point in the UMTS at which one or more than one cell site’s radio interface goes into the UTRAN — to the 3G mobile switching center (MSC)/GGSN with a common technology base, common ForeThought® internetworking software and traffic engineering, and ServiceOn® Data network management.

**BXR-48000 core switch router**

The BXR-48000 was purpose-built to fully support IP and ATM in their native formats — without the need to convert cells to frames or frames to cells in order to make a forwarding decision. This unique architecture creates the best possible platform for supporting the R99 recommendations while planning for the deployment of R5. There is no performance penalty associated with the BXR-48000, which can support ATM today and IP tomorrow — unlike an IP/MPLS router with ATM interfaces today.

Knowing the BXR-48000 would be deployed in network cores, Marconi engineers took great pains to ensure that the attributes of the BXR-48000 were those of a highly flexible core switch router. Four of the most fundamental requirements for core networks, and those which the BXR-48000 was specifically developed for, are
- reliability,
- scalability,
- versatility, and
- predictability.

**Reliability for carrier-class networks**

The converged UMTS core network is the critical infrastructure that links all UMTS elements. UMTS providers depend on reliable network components to deliver uninterrupted service to their customers. The BXR-48000 was engineered with carrier-class hardware and software that is NEBS Level 3 compliant and delivers availability that exceeds 99.999 percent.

In addition, the BXR-48000 has no single point of failure. All hardware components are hot swappable, including the following:
- Power modules
- Fan trays
- Timing modules
- System control processors
- Port cards
- Fabrics

Each of these components is individually and optionally protected.

Fabric errors and failures are protected via a zero-packet-loss protection scheme. Port and port card failures are detected automatically via Synchronous Digital Hierarchy (SDH) multiplex section protection (MSP) and/or intelligent internal diagnostics.

The BXR-48000 offers several software features that build on its carrier-class reliability, including the following:
- **Call/connection preservation** – This feature maintains permanent and signaled ATM and MPLS connection types and traffic flows across all connections during software upgrades, component failures, and maintenance operations, providing a hitless upgrade path.
- **Distributed Protection Switching (DPS)** – This feature enables automatic connection preservation upon detection of network failures such as lost links, switch failures, or carrier failures. Both the source and the destination for a virtual circuit (VC) can be protected, which creates a unique, rapid, and unprecedented level of protection for voice and data services.

With the BXR-48000 providing a reliable platform for carrier-class networks, UMTS providers can gain a competitive edge by offering service level guarantees to mobile customers.
Scalability without compromising performance

Mobile providers require a network infrastructure that scales. It must scale in capacity and performance in order to support new and existing services, protecting initial UMTS core network investments while growing revenues. Platforms with limited scalability generate network equipment churn, resulting in greater expenditures.

The BXR-48000 redefines scalability. It is scalable in throughput, interfaces, connections, signaling, and routing performance. The fact that BXR-48000 achieves this massive scalability while continuing the Marconi tradition of delivering the highest-performing core products makes it unique in the industry.

The BXR-48000 scales from 40 Gbps to 480 Gbps of capacity, measured using the most stringent benchmark — full-duplex (bidirectional), deterministically non-blocking throughput — with zero hit to service. Less stringent methods can inflate capacity claims by double counting bandwidth, measuring internal capacities rather than actual usable capacity, or aggregating the total bandwidth of clustered chassis using a “rodeo” technique.

In addition, many fabric architectures are being implemented to emulate the performance of single-stage, output-buffered devices. While these architectures may scale in capacity, they may not scale in performance, limiting functionality of multicast and even unicast services during periods of congestion.

The BXR-48000 boasts impressive port capacity, supporting up to 768 OC-3c/STM-1, 768 OC-12c/STM-4c, 192 OC-48c/STM-16c, 48 OC-192c/STM-64c, 480 Gigabit Ethernet, or forty-eight 10 Gigabit Ethernet in the 480 Gbps configuration. Each of these ports supports full line-rate performance at all interface rates.

In addition, the BXR-48000 supports scalability in performance. This flexible switch router supports up to 2 million connections of any type. Plus, the high-performance system control processors and the optimized control architecture continue Marconi’s tradition of leading signaling performance.

Versatility for IP and multiservice offerings

Mobile providers need networks that allow them to offer new differentiated services and support existing service offerings from a single platform. The BXR-48000 architecture supports packet over SONET (POS), ATM, 1/10 Gigabit Ethernet, Time Division Multiplexing (TDM), and Frame Relay services. The Marconi platform is optimized to support IP, MPLS, and ATM control planes simultaneously; it also supports all the services that each of these control planes supports.

Configured as an IP/MPLS switch router, the BXR-48000 supports a wide range of IP protocols, including the following:

- Border Gateway Protocol version 4 (BGP-4)
- Intermediate System–to–Intermediate System (IS-IS)
- Open Shortest Path First (OSPF)
- Protocol Independent Multicast, sparse mode (PIM-SM)
- PIM, dense mode (PIM-DM)
- Multiprotocol BGP
- IPv4 (IPv6 ready)

The BXR-48000 also supports DiffServ-aware traffic engineering and MPLS signaling protocols — including Resource Reservation Protocol with traffic engineering extensions (RSVP-TE) and Label Distribution Protocol (LDP) — to enable differentiated and scalable IP service offerings.

When configured as an ATM-only switch, the BXR-48000 supports existing voice, video, and data service offerings with a standards-based User–Network Interface (UNI) 3.x/4.0, Hierarchical Private Network–Network Interface (H-PNNI), and ATM Inter-Network Interface (AINI).

The BXR-48000 also has the capability to operate as an integrated switch router. This mode requires dual control planes — ATM and MPLS — to operate in the same physical device. Instead of ATM and IP/MPLS routing and signaling protocols running simultaneously on the same ports of the same node, the integrated switch router model has separate physical interfaces on the same node (e.g., ATM and POS). The ATM and POS interfaces coexist on the network side of the switch and route the traffic in their native format, either ATM cells or IP/MPLS packets. ATM switches and IP/MPLS routers perform double conversion (routers convert ATM cells to packets and then back to cells for ATM forwarding), a highly inefficient — and delay inducing — process. The BXR-48000 handles both IP and ATM in their native formats, without conversion.
Therefore, cell-based ports of the BXR-48000 are set up with the ATM control plane configured for standard ATM routing and signaling. The ATM control plane supports ATM Forum UNI for access links (Iub, IuR, Iu-CS, Iu-PS) and Network–Network Interface (NNI) for inter-switch links. The ATM Forum PNNI signaling and routing protocol is the signaling and trunking technology. On these ATM interfaces, the BXR-48000 performs as a conventional ATM switch.

On the same BXR-48000, but on separate physical ports, the IP and MPLS control plane protocols handle IP, MPLS, and packet services. These protocols include Interior Gateway Protocol (IGP) — e.g., IS-IS or OSPF (with and without TE extensions) and BGP (with TE extensions). The MPLS control plane also is responsible for running standard MPLS signaling protocols like RSVP-TE and/or LDP. On MPLS POS interfaces, the network supports the currently acceptable standards relative to conformance and performance. In this configuration, the BXR-48000 offers the same level of carrier-class reliability for both the ATM and IP portions of the network design.

The BXR-48000 MPLS gateway functionality complements this network model and bridges the ATM and MPLS domains with static interworking through transparent tunneling. Moreover, Marconi is driving the ATM Forum standardization efforts for dynamic ATM–MPLS interworking which, when implemented, will run most efficiently on a single node such as the BXR-48000.

When operating in the integrated switch router mode, the BXR-48000 is uniquely positioned to integrate and simplify both the UMTS core network and the UTRAN, dramatically reducing capital and operational costs and complexity.

**Predictability for IP, MPLS, and ATM**

The UMTS infrastructure will support time-sensitive voice traffic, multimedia data flows, and basic data services. Successful service providers realize that revenue growth comes from creating product and service portfolios that differentiate them from their competition. Predictability and service guarantees are key opportunities for differentiation. By using MPLS and/or ATM, UMTS providers can build a predictable, converged core network and offer differentiated, predictable IP services to generate additional revenue streams.

The BXR-48000 provides leading capabilities that deliver predictability in service provider networks. The architecture of the BXR-48000 provides single-stage, deterministically non-blocking switching and routing. This architecture is ideal for optimizing throughput and multicast performance for all traffic and connection types. In addition, traffic management and traffic engineering features such as per-QoS, per–VC, and per–LSP policing, queuing, and scheduling provide the greatest granularity of fairness to ensure that no one user or traffic flow can unfairly abuse a service provider’s network.

With the BXR-48000, mobile operators can build a core network with hard QoS guarantees and full throughput in all traffic scenarios, not just the “most typical” traffic scenarios. The BXR-48000 gives service providers the freedom to redefine service differentiation with predictable IP, MPLS, and ATM transport. Marconi products have earned their reputation as the industry’s premier traffic management platforms by serving as key components in the cores of some of the world’s largest Internet service provider (ISP) and interexchange carrier (IXC) networks.

The BXR-48000 enables UMTS operators to support a broad array of services and provide their customers with assurances of reliable delivery by supporting features such as

- static and active queue management (e.g., cell loss priority [CLP] 0/1 and weighted random early discard [WRED]),
- load balancing,
- connection priorities, and
- protected QoS classes (guaranteed and best effort).

**Conclusion**

The UMTS network core is the foundation of the UTMS network, the high-margin 3G services expected of UMTS, and revenues those services will generate. Building a UMTS core that could support R99, R4, and R5 in one flexible, scalable chassis would control CapEx and reduce OpEx. With a single high-performance platform capable of supporting the most demanding real-time services while transporting low-margin best-effort data traffic, there would be fewer platforms to manage, fewer spares to maintain, fewer software images to track, and less training for network operations.

Operators can realize these single-platform benefits with the BXR-48000, which performs equally well as an IP/MPLS router and an ATM switch, permitting mobile operators to deploy MPLS on a phased, as-needed basis. Routers with ATM interfaces could be used in this fashion, but the capability of MPLS to support high-performance real-time services could delay plans to deploy high-margin services. In a similar fashion, ATM switches with IP interfaces might provide a gateway to an MPLS core, but conversion of ATM cells into IP packets can induce unwanted performance characteristics on new real-time services.

With the Marconi BXR-48000, mobile UTMS operators can be confident that new high-margin, multimedia services will coexist with voice and data services of the 3GPP R99 recommendation without compromising performance or efficiency.